VOLUME XXVIII NUMBER 6

BOTANICAL GAZETTE

DECEMBER 1899

SOME ROCKY MOUNTAIN CHRYSOTHAMNI.

AVEN NELSON.

AFTER an experience of several years as a collector and as a student of this group both in the field and in the herbarium, I have reached the conclusion that the genus Chrysothamnus, as it exists in the Rocky mountains, is still to an unsuspected degree unknown and unappreciated.

The plants of the far west became known to the botanical world at an earlier day than those of the interior west, and it seems to have been assumed that the species of the two regions ought to be the same. As a result of this assumption we have been producing a confusion in the herbaria that will be cleared up with difficulty. Dr. Greene's[1] papers on this genus represent the first attempt to do justice to the species of the range in question. In this genus, as in many others, Nuttall's knowledge obtained in the field has been discounted, but, like other attempts to subordinate his species, it has simply resulted in confusion.

The following notes it is hoped may be serviceable not only to resident students, but to all who are interested in this characteristic western genus. The new species that are proposed, while intended in some instances to simplify by segregation, are in others believed to represent species not heretofore collected. Only such species are included in this paper as belong

[1] Erythea 3:92–96; 107–115. 1895.

to that natural botanical region of which Wyoming, with its high arid plains and mountain ranges, is the center. Localities mentioned are in Wyoming unless otherwise stated.

CHRYSOTHAMNUS GRAVEOLENS Nutt.— For the literature of this species and a thoroughly usable characterization see *Erythea* **3**: 108. 1895. Its range as there given, and the habitat, "denudated soils," given by Nuttall, will prevent confusing with this certain other species that have been too often included. Thoroughly typical are the following collections: George E. Osterhout, New Windsor, Colo., September 8, 1898; the writer's nos. 503 and 2758 from the Platte cañon, in 1894 and 1896.

CHRYSOTHAMNUS PLATTENSIS Greene, Pitt. **4**: 42. 1899. *C. speciosus Plattensis* Greene, Erythea **3**: 111. 1895.—This is the representative in this range of the far northwestern *C. speciosus* Nutt.[2] I know of no specimens except from the eastern base of the Rockies. Well represented by the following collections: C. S. Crandall, Fort Collins, Colo., September 17, 1898; George E. Osterhout, New Windsor, Colo., September 8, 1898; E. L. Greene, LaSalle, Colo., September 10, 1896; the writer, Cheyenne, Wyo., August 27, 1896.

Chrysothamnus pulcherrimus, n. sp.—Shrub 0.5–1.5^{m} high, tree-like in form (a short trunk-like base much branched above); main stem and branches with grayish bark, the season's stems yellow but under the lens minutely lanate-puberulent, rather slender-virgate, terminating in an ample, compact, paniculate cluster: leaves moderately numerous, narrowly linear, rather lax and spreading, 5–8^{cm} long, from white-tomentose to greenish-glabrate: involucral bracts only two or three in each row, oblong, acute, nearly glabrous, ciliate on the margins: corolla tube longer than the throat into which it gradually expands, rather closely short-hairy: anthers well exserted, the appendages of the style exceeding these: akene softly pubescent.

A handsome shrub, its arboreous habit, numerous, slender branchlets, and large trusses of bright yellow flowers make it one of the strongly characterized and conspicuous species. It is to be distinguished from *C. graveolens*

[2] This and its var. *albicaulis* is sometimes reported from this range, but I believe cannot be authenticated.

Nutt., to which it is allied on the one side, by its less glabrate condition, its narrower leaves, yellow stems, paniculate (not corymbose) inflorescence, and proportionately shorter style appendages. From *C. speciosus* Nutt., to which it must be compared on the other side, by its stout yellow (not whitish) branchlets, its longer less filiform leaves, glabrate involucral bracts, pubescent corolla tube, and more open-paniculate inflorescence.

Under no. 2066 it has been distributed as *C. speciosus*, from Cummins, August 10, 1896. Collected near the same locality (Wood's Landing), August 9, 1897, no. 3477, the latter taken as the type number. Specimens from Gros Ventre river, August 23, 1894, no. 966, is a form with more virgate and glabrate branchlets.

CHRYSOTHAMNUS PULCHERRIMUS **fasciculatus,** n. var.— size and habit of the species; the season's branchlets short, numerous, forming a brush-like fascicle at the ends of the woody branches: leaves numerous, short ($2–3^{cm}$), somewhat rigid, green or yellowish-green, with a thin tomentum: inflorescence similar to that of the species but smaller, terminating the numerous branchlets.

The fascicled branchlets and short rigid leaves suggest *C. collinus* Greene, but the size, habit, inflorescence, and floral characters are those of *C. pulcherrimus*. *C. collinus*, in its pubescent long acuminate bracts, is quite in contrast to this.

First collected in 1894 on Boulder creek, August 26, no. 1120; in 1897 at Creston, August 28, no. 4419 and distributed as *C. speciosus*.

CHRYSOTHAMNUS FRIGIDUS Greene, l. c.— What is typical of this species is not quite clear (see note under var. *concolor*), but it seems plain that it was intended to include that superabundant but variable species of the high plains, popularly known as "rabbit-brush." It is illustrated by Dr. Greene's specimens from Laramie, August 10, 1895; the writer's nos. 2787, 5280, 5282, 5315.

CHRYSOTHAMNUS FRIGIDUS **concolor,** n. var.— Yellowish-green throughout except for the bright yellow flowers, $3–4^{dm}$ high from a barely shrubby base, the numerous stems rather slenderly virgate, terminating in a narrow thyrsus (sometimes paniculate corymbose): leaves linear, erect or irregularly spreading, $4–7^{cm}$ long, $1–2^{mm}$ wide: bracts mostly acute, the outer with a light tomentum like that of the stems and leaves, all with a thin, scarious-ciliate margin: corolla tube short-pubescent.

Though I believe this to be a species, I hesitate to separate it from *C. frigidus* so long as I am unable to say what is typical of the latter. Ever since its publication (*Erythea* 3 : 112. 1895), based upon specimens (one of which I have) collected at Laramie by Dr. Greene, I have collected freely in this genus. Though in the center of distribution for *C. frigidus*, and in spite of the large series representing it, I have never secured duplicates of the specimens distributed by Dr. Greene, nor any quite typical, judged by the description. Assuming that the plant, so common on the Laramie plains, of which there seem to be several forms, must stand as *C. frigidus*, the preceding may at least be ranked as a variety, no matter what may be typical of the other. Nor may this be connected with *C. Plattensis*. Some forms of that seem to connect very closely with *C. frigidus*, but typical specimens of the two are really widely different. *C. Plattensis* one at once associates with *C. speciosus* on general appearance; not so with *C. frigidus* and the variety now proposed.

Collected on the banks of Hutton lakes, in rather sandy, but more or less alkali impregnated soil, September 6, 1898, no. 5300.

Chrysothamnus pallidus, n. sp.—A small tufted shrub, 2–5^{dm} high, with a close felted tomentum which persists even on the old stems: stems rather scraggy branched, somewhat rigid, the season's twigs very short: leaves mostly confined to the season's growth, the tomentum looser than on the stems, ascending, irregularly spreading or reflexed, linear, acute, 2–3^{cm} long, shorter and crowded at the base of the inflorescence: heads small, in thyrsoid panicles or somewhat corymbosely clustered cymes; involucre short, sub-campanulate, its bracts short, oblong, subacute, ciliate-pubescent especially on the margins, about three in each row: tube of the corolla closely covered with short, clavellate hairs, the throat longer than the tube and cleft one third its length: style divisions exserted, the stigmatic portion about as long as the appendages: akenes densely pubescent, about equaling the corolla tube.

Allied to *C. frigidus* but distinguished by its more rigid, scraggy branches which are leafy only on the branchlets; by the close, persistent, white indument; by the shorter bracts, florets, akenes; by the exserted style divisions and the denser hairiness of the corolla tube.

Seemingly a rare plant; collected on an alkaline flat near Laramie, September 24, 1898, no. 5347. Also on Bacon creek, August 15, 1894, no. 910.

Chrysothamnus Wyomingensis, n. sp.—Tufted, 2–4^{dm} high, bushy-branched from the base, the branches with ascending or

erect, yellowish-green branchlets, with a thin inconspicuous tomentum throughout: leaves rather numerous, especially above, 4–6^{cm} long, narrowly linear, sharp-pointed, plane or somewhat canaliculate, viscidulous as are also the branchlets: inflorescence a narrow thyrsiform-panicle, rather leafy, at maturity barely surpassing the uppermost leaves: heads about 12^{mm} high; bracts few (10–14), not in strict vertical ranks, mostly acute or acutish, glandular on the greenish keel, from glabrate to ciliate-pubescent: corolla tube and throat scarcely distinguishable, but slightly expanded upward, the lobes about one eighth of the whole length, obscurely short-pubescent below: style branches exserted, the appendages longer than the stigmatic portion.

This species has been secured but twice, both times on strongly saline soil, viz., at Buffalo, July 25, 1896, no. 2495, and on Vermilion creek, July 24, 1897, no. 3590. Its nearest ally in habit and some other characteristics is *C. frigidus*, but in form of inflorescence it approaches *C. Parryi* (Gray) Greene. It differs from *C. frigidus* in being almost devoid of tomentum, in its yellowish branches, its green leaves, narrow leafy inflorescence, and its exserted styles. It is also an earlier plant, one of the earliest of the several species of this genus in this region.

CHRYSOTHAMNUS PARRYI (Gray) Greene, l. c.—The habitat and range of this well-known species is always given as "parks of the Rocky mountains in Colorado," but certainly similar parks in southern Wyoming, at least, must be added. Typical specimens are, J. H. Cowen, Breckinridge, Colo., August 1896; the writer's nos. 2617 and 3495, Lincoln gulch, August 1896 and Big creek, August 1897.

CHRYSOTHAMNUS HOWARDI (Parry) Greene,[3] l. c.—The habitat of this, like the preceding, is given as "parks of the Rocky mountains," but it should be stated that the *parks* are very different in their character. *C. Parryi* inhabits moist open ground, known as parks, occurring at intervals in the timbered mountain ranges. *C. Howardi* inhabits that other class of parks, viz., extensive, high, dry table-lands like North Park, Colo. and the Laramie plains. It occupies the dry foothills and ridges and I doubt not

[3] Dr. Greene's papers cite the literature of all the well-known species so fully that it here seems necessary only to call attention to this fact.

may occur on the eastern base of the Rockies, possibly extending into eastern Nebraska, as given in Britton & Brown's *Flora*, a statement questioned by Dr. Greene. It seems probable that some confusion on this point has arisen by the distribution of a somewhat similar plant occurring in situations much like those in which *C. Parryi* occurs. This plant I think should stand as a species, and may be named as below.

Chrysothamnus affinis, n. sp.—Scarcely shrubby, the persistent base hardly more than a much-branched woody caudex: the season's stems very numerous, simple, 1–2^{dm} high, yellowish, glabrate: leaves crowded, narrowly linear, acute, erect or spreading, dark green, nearly glabrous, 3–4^{cm} long: inflorescence a crowded spicate thyrsus which at maturity distinctly surpasses the leaves: bracts glabrate, arachnoid-ciliate on the margins, somewhat thickened-coriaceous, about three in each row; the outer with an ovate base, contracted in a usually spreading acumination; the inner linear-oblong, abruptly acuminate, shorter than the pappus: corolla tube slender, bearing only a few, minute, scattering clavellate hairs, shorter than the expanded, tubular throat which is cleft about one fourth its length: style appendages tardily but at length wholly exserted: akene linear-cylindric, about 6^{mm} long.

Allied to *C. Howardi* (Parry) Greene, but clearly distinct by its less shrubby habit, its greenish glabrate aspect, and its crowded yellow inflorescence which surpasses the leaves. *C. Howardi* has cinerous leaves and stems, a dirty whitish-yellow inflorescence, and the leaves overtop the comparatively few and large heads whose bracts are distinctly arachnoid.

Excellent specimens were collected by J. H. Cowen, Jefferson, Colo., August 1896, and distributed as *Bigelovia Howardi* Gray. Type in Herb. University of Wyoming.

CHRYSOTHAMNUS AFFINIS **attenuatus,** n. comb. (*Bigelovia Howardi attenuata* Jones, Proc. Cal. Acad. Sci. II. **5**: 691. 1895.—The specimen of Mr. Jones' type number, 5912, seems to approach *C. affinis* much more closely than it does *C. Howardi.* Its more persistent stems and longer branchlets, its very long acuminate bracts, and long exserted styles will readily distinguish it.

CHRYSOTHAMNUS COLLINUS Greene, Pitt. **3**: 24. 1896.—This distinct and clearly characterized species I think has not been

collected except by the writer (no. 4435, Point of rocks, August 1897, near the type locality) since the original specimens were collected at Rock springs by Dr. Greene.

Chrysothamnus oreophilus, n. sp.—Green and nearly glabrous, 2–4^{dm} high: stems several to many, from a thick woody base, strictly erect and somewhat fascicled, grayish with a thin tomentum, the annual twigs arising from near their summit, these also fascicled-erect, slender and yellowish-green: leaves erect, linear-filiform, very acute, canaliculate, green and glabrate, 3–5^{cm} long: heads small (about 1^{cm} high), in small fastigiate cymes: bracts oblong, abruptly sub-acute, only two or three in each vertical row, the scarious margins ciliate-pubescent: corolla sparsely short-hairy, divisible into three equal regions (tube, throat proper, and a transition region); lobes more than half as long as the tube proper, distinctly glandular-thickened at apex: pappus rather sparse: style appendages longer than the stigmatic portion, at length exserted: the short akene finely pubescent.

The erect habit of stems, the twigs and leaves, the greenish aspect, and numerous but small flower clusters mark this as peculiarly distinct from the other species of this range. It is abundant on stony slopes in the Bear river hills, near Evanston. Type number 4105, July 27, 1897. Represented also by M. E. Jones' no. 6040, distributed unnamed.

CHRYSOTHAMNUS PUMILUS Nutt., Trans. Am. Phil. Soc. **7**: 323. 1840.—The recharacterization by Dr. Greene,[4] after every possible effort has been made to settle what was the original of the species, is of noticeable service to us all. This common and somewhat variable species is now recognizable. It is well represented by the following numbers from various parts of Wyoming: 617, 903, 1121, 1197, 2883, 3524 and 5398. The last, from Hutton's lake, September 7, 1898, is typical so far as I am able to judge.

CHRYSOTHAMNUS PUMILUS **varus**, n. var.—Smaller than the species, only 1–3^{dm} high, the shrubby base divaricately scraggy branched, the season's branchlets slender, very numerous, 5–15^{cm} long, with a whitish or straw-colored bark: leaves glabrous except for an obscurely scabrous margin, linear, almost filiform,

[4] Erythea **3**: 93. 1895.

one-nerved, somewhat involute and usually more or less twisted, irregularly and widely divaricate, very numerous on the new wood and often fascicled on two-year old branches, short, rarely exceeding 3^{cm}, usually much shorter: inflorescence and bracts much as in the species.

This is what has often been called in this range *Bigelovia Douglasii stenophylla* Gray. I have distributed some specimens under that name, but I am now satisfied that that is a very different plant and belongs to a more western range.[5] It occurs mostly on dry ridges and stony or sandy slopes. Type of the variety is no. 1847, Centennial valley, August 26, 1895. Another collection is no. 4434.

CHRYSOTHAMNUS PUMILUS **acuminatus**, n. var.—The habit of the species: numerous slender stems from a woody base $2–3^{dm}$ high, with whitish bark: leaves numerous but early deciduous below, crowded toward the inflorescence, nearly filiform, ascending, somewhat twisted, $2–3^{cm}$ long: inflorescence more paniculate than in the species; bracts lanceolate, long-acuminate with more or less spreading tips, nearly equaling the 5–6 flowered disk.

This variety I have from La Veta, Colorado, only, collected by Professor C. S. Crandall, August 21, 1897.

CHRYSOTHAMNUS LANCEOLATUS Nutt. l. c.—I see no reason for reducing this to a variety. Numerous collections of it show as much constancy in the essential characters as most of the recognized species. Its low tufted habit, its uniformly scabro-puberulent surface, and its either plane or twisted lanceolate leaves make it not hard to recognize. Specimens by the writer, nos. 889, 905, 2672, 2793, 5294 and 5314 are representative, as is also Professor Crandall's from Walden, Colorado, July 1894.

CHRYSOTHAMNUS GLAUCUS Aven Nelson, Bull. Torr. Bot. Club **25**: 377. 1898.—At the time this was published only meager material was at hand, but it has since been secured in abundance. The characters as given are well borne out, except that in old specimens the leaves are less glaucous.

[5] I think it should be noted that *C. viscidiflorus* Nutt. l.c. (*Bigelovia Douglasii* Gray) occurs probably in a range to the northwest of that now under consideration, and that several of its varieties, though often attributed to the eastern Rockies, are not in this range at all. Among such may be named vars. *latifolius*, *serrulatus*, and *tortifolius*.

CHRYSOTHAMNUS LINIFOLIUS Greene, Pitt. **3**: 24. 1896.—This I think has not been secured except in south-central Wyoming, where it occurs on the banks of strongly saline creeks. Its halophytic and hydrophilous nature is very marked, as it often grows with its "feet" in water so strongly impregnated with salts as to be wholly unfit for any use whatever. Its original collection was by the writer, on Poison Spider creek, no. 618, July 1894, but it was published upon material collected by the author of the species at Rock springs, August 1896. The writer has collected it also at Bitter creek and at Granger, nos. 4143 and 4137.

CHRYSOTHAMNUS VASEYI (Gray) Greene, Erythea **3**: 96. 1895.—As pointed out by Dr. Greene, this has an akene quite at variance with the species that have preceded. The range given for it is too limited, for certainly very characteristic specimens are at hand as follows: G. E. Osterhout, North Park, Colorado, September 1897; by the writer, Big creek, August 11, 1897, no. 3494, and near Laramie, September 1898, no. 5331.

UNIVERSITY OF WYOMING,
Laramie, Wyo.

ON THE TOXIC EFFECT OF DELETERIOUS AGENTS ON THE GERMINATION AND DEVELOPMENT OF CERTAIN FILAMENTOUS FUNGI.

J. F. CLARK.

(*Concluded from p. 327.*)

ALL acids tested retard germination and early mycelial development of the mold fungi. In the case of the mineral acids this retarding action is usually evident in $\frac{n}{1024}$ concentration. The acetic acids do not have any perceptible influence at this dilution. Cultures which are only slightly retarded almost invariably take on new vigor a few hours after germination, and overtake and surpass the checks in development of mycelium. This excessive mycelial development is usually accompanied by retardation of fruiting, and usually reaches its maximum in cultures two or three removes from the inhibiting concentration. Cultures in the acetic acids show a greater stimulation of mycelial development than in HCl or H_2SO_4. Cultures in HNO_3 resembled those in the acetic acids in development of mycelium but were not so greatly retarded in fruiting.

Smaller quantities of acid on an average proved injurious to Œdocephalum than to the other forms, $\frac{20n}{2048}$ being on the average distinctly detrimental. In this respect the others came in the following order: Botrytis, 23; Penicillium, 28; Aspergillus, 42; Sterigmatocystis, 64.

Œdocephalum was also the most easily inhibited, its relative inhibiting coefficient being 72; followed by Botrytis, 76; Penicillium, 100; Aspergillus, 104; and Sterigmatocystis, 200.

Botrytis, however, was the most easily killed. The order in this respect was: Botrytis, 100; Œdocephalum, 137; Aspergillus, 272; Sterigmatocystis, 369; and finally Penicillium, whose spores showed by far the greatest resistance, represented by the

coefficient 498. This high resistance of Penicillium in regard to the death-point may be partly due to the tendency of the spores to adhere in bunches in making the inoculation, a difficulty never fully overcome.

In table II a comparison of the chemical affinities of the different acids tested by seven methods is given.

TABLE II.

CHEMICAL AFFINITIES OF ACIDS.

HCN	Tri.	Di.	Mono.	Acetic	$\frac{1}{2}H_2SO_4$	HNO_3	HCl	Acid
—	62.3	25.3	4.9	1.4	65.1	99.6	100	Relative ionization in $\frac{n}{1}$ sol.
—	68	23	4.3	.34	74	92	100	Catalysis of methyl acetate
—	63	18	5.1	1	67	110	100	Catalysis of calcium oxalate
—	82	34	7.2	1.2	68	102	100	Neutralizing hydroxids
—	75.4	27	4.9	.4	73	100	100	Invertion of cane sugar
—	96.7	62.4	17.2	4.7	71.9	99	100	Multirotations of dextrose
200+	200	100+	100	25	100	100	100	Physiological action on Lupinus
7666	255	359	396	277	112	163	100	Ditto, on molds

Line 1 gives the relative ionization of these acids (except HCN) in normal solution. HCl being the basis of comparison here as in the succeeding tests is given 100 units. Line 2 gives the relative powers of the different acids to promote the well known catalysis of methyl acetate in aqueous solution. Line 3 gives their relative activity in decomposing calcium oxalate. Line 4 gives Ostwald's ('91) determinations of their relative affinities for hydroxids. Line 5 gives their relative activity in inverting cane sugar.

The correspondence of the results presented on lines 2–5 with the ionization data on line 1 is certainly quite striking. Arrhenius ('83) was the first to point out this close numerical agreement. Since the publication of his work in 1883 the idea has taken firm hold on many chemists that the ionized portion of an acid and that only is chemically active. Whetham ('95)

expresses concisely recent views when he says (p. 165): "We may take it, then, that only that portion of a body is chemically active which is electrolytically active — that ionization is necessary for chemical activity just as it is necessary for electrolytic conductivity."

What applies to chemical activity must also apply to physiological activity, for in its ultimate analysis the latter is doubtless due to the former. Kahlenberg and True ('96) remark (p. 35): "It has always been taken as axiomatic that the physiological action of any substance is due to its chemical character."

The first work which deviated irreconcilably from the theory that all acids have "specific coefficients of affinity . . . . based on the fact that the relative affinities of different acids are the same, whatever the nature of the action by which they are compared" (Whetham, '95, p. 162) was that of Levy ('95). It will be seen (line 6) that acetic, mono- and dichloracetic give coefficients of activity which are in round numbers 200 per cent. in excess of that called for by the theory. The physiological activity of the acids towards phanerogams (Kahlenberg and True '96) (line 7) is equally out of harmony with the theory, when we find the almost un-ionized HCN much more active than the "strong" mineral acids. The climax, however, is reached in the data recorded on line 8, where we are dealing with concentrations which contain in many cases a very large proportion of un-ionized molecules.

The chemical reactions involved in physiological investigations are doubtless vastly more complex than in the case of the earlier studies recorded on lines 2–5. In the data recorded on lines 6–8, derived from the action of the acids on the more complex carbon compounds, and the highly complex aldehydes, albuminoids, etc., found in the protoplasm of living cells, we surely find a great exception to the alleged law that the relative affinities of different acids are the same *whatever the nature of the action by which they are compared.* These affinities, indeed, appear in some cases to be almost the converse of that required by the theory above noted.

HYDROXIDS.

As it is quite impossible to handle solutions of hydroxids in an ordinary atmosphere without a greater or less loss by neutralization by the CO_2 of the air, the following toxic values of potassium hydroxid and ammonia must be somewhat less than their absolute toxic value. This source of error was reduced as much as possible by rapid handling in making the cultures.

Potassium hydroxid, KOH; 77 (?), *166*, 282. In no other case was it found so difficult to determine where to place the coefficient of injury. $\frac{n}{512}$ retarded germination in all cases, and with some forms $\frac{n}{1024}$ and even $\frac{n}{2048}$ (Œdocephalum) showed an injurious influence.

At 24 and 36 hours, however, the cultures presented a very different appearence. Cultures in $\frac{n}{2048}$ concentration showed a heavier mycelium than the checks, and with stronger concentrations this stimulation of mycelial development was more marked until the climax was reached in $\frac{n}{64}$ or $\frac{n}{32}$ concentration.

As $\frac{n}{12}$ proved the average inhibiting point, it will be seen that, as with the acids, the maximum stimulation of mycelial development occurred about two removes from the limit of germination, or, in other words, in solutions containing one fourth the concentration of the agent inhibiting the germination of the spores. The retardation of fruiting in the stimulated cultures was very marked, and suggested the query as to whether they were both due to the same cause, or whether one was a result of the other. It is well known that with the higher plants suppression of fruiting tends to force the energies of the plant into vegetative lines, and it is not apparent to the writer why this should not be true of the fungi also. On the other hand, Botrytis, which did not fruit, showed nearly or quite as great a stimulation of mycelial development as any other form.

The toxic properties of KOH are probably largely due to the $\bar{O}H$ ion. It is about 94 per cent. ionized at $\frac{n}{12}$ (Ostwald '86), its inhibiting point. Just what proportion of the toxic properties is to be attributed to the remaining 6 per cent. un-ionized KOH we have as yet no means of knowing. Inasmuch, however, as KOH is more highly ionized than HCl at the inhibiting point and is distinctly more toxic, we may safely conclude that the $\bar{O}H$ ion is somewhat more toxic for fungi than ionic $\overset{+}{H}$.

Ammonium hydroxid, NH_4OH; 29 (?), *51*, 83. This hydroxid, in contrast with KOH, is but slightly ionized, $\frac{n}{40}$, the inhibiting concentration, being about 8 per cent. ionized (Kohlrausch '85.) Its high toxic value is then doubtless due very largely to the un-ionized molecule.

Like KOH, although to a less degree, it caused a marked stimulation of mycelial development in many cultures. It is worthy of note that Sterigmatocystis, which is particularly resistant to both ionic $\overset{+}{H}$ and $\bar{O}H$, proves quite susceptible to both acids and hydroxids in the molecular form.

These results with hydroxids are not in harmony with those obtained by Krönig and Paul ('97) with anthrax spores. They found that the bases KOH, NaOH, LiOH and NH_4OH "*disinfect in direct proportion to their degree of ionization*," NH_4OH being practically non-toxic. Anthrax spores have evidently a great specific resistance to this agent, and perhaps even a general comparison would be unfair. Be this as it may, ammonia is without doubt one of the more violent poisons for fungi, far surpassing the mineral acids, copper, cobalt, etc., in toxic properties, and comparing favorably with KCN.

Data as to the effect of hydroxids on the higher plants are rather meager. Kahlenberg and True ('96) found Lupinus to survive in $\frac{n}{200}$ KOH. As ionization is practically complete here, Lupinus is evidently much more resistant to $\bar{O}H$ than to

ionic $\overset{+}{H}$. Bokorny ('88) found that ammonia in $\frac{n}{689}$ concentration, in common with other basic substances, caused the production of granules in the protoplasm of Spirogyra cells, but failed to modify otherwise the normal activities of the cell. Detmoor ('94) found that a 10 per cent. solution of ammonia at first energetically excited the protoplasm of Tradescantia hairs, later producing anæsthesia. Washing with water, however, restored the original characters of the protoplasm. From these data it would seem that hydroxids are more fatal to the molds than to the higher plants.

Formaldehyde, HCHO; 0.553, *1.43*, 2. Formaldehyde, as was anticipated, proved to be one of the most deadly agents tested, being surpassed in this respect by mercury, silver, and the two chromates only. Chemically considered, formaldehyde is a very unstable compound intermediate between methyl alcohol and formic acid, being in fact the intermediate step in the oxidation process by means of which the latter is derived from the former. It is both a reducing and oxidizing agent, and this together with its great instability may account for its extremely toxic properties toward fungi.

To many kinds of protoplasm, including that of the higher animals and perhaps the higher plants, formaldehyde is non-toxic. Instances are on record of persons having drunk a 1 per cent. solution without inconvenience (Arthur '97, p. 21). To the lower animals, however, it is more toxic, $\frac{n}{60}$ being fatal to worms, mollusks and isopods in two hours (Loew '88). Acton ('89), in experiments on the assimilation of organic compounds by green plants, found that while they could use glucose, saccharin, glycerin, etc., they failed to use aldehydes or their derivatives. Cohn ('94) found a 1 per cent. solution very fatal to Spirogyra.

For the fungi, however, there is no doubt that in formaldehyde we have one of our safest, most energetic, and most serviceable poisons. $\frac{n}{512}$ proved fatal to Aspergillus and Penicillium;

$\frac{n}{2048}$, to Sterigmatocystis and Botrytis. Œdocephalum was inhibited by $\frac{n}{16384}$, and killed by $\frac{n}{8192}$. This will perhaps be better appreciated if stated in another way. One part by weight in 273,066 parts beet infusion proved fatal to Œdocephalum, and 1 part in 4,369,066 permitted the germination of but 10 per cent. of the spores in eleven hours (as compared with 95 per cent. in four hours in the checks) and greatly injured the mycelial development. In regard to the other forms, 1 part to 273,066, although greatly retarding germination, caused a distinct stimulation of mycelial growth on the second day. These stimulated cultures resembled those growing in media containing alcohol.

Very interesting in this connection are the theories regarding the synthesis of starch in green plants, and of the proteids in the fungi (Kozlowski '99), in both of which formaldehyde has long been regarded as forming a very important step. These theories, particularly that in regard to the synthesis of proteids in the fungi, challenge further careful investigation. It seems, *prima facie*, inconceivable that a compound markedly injurious to a plant when present in the almost infinite dilution of one part of weight in 4,369,000 parts nutrient medium, as is the case of Œdocephalum, should be formed by the protoplasm of that plant and be used again in the synthesis of its proteids, as must be the case if our theories be correct.

In regard to the nature of its toxic action we have few data. It is believed to act upon the propeptones and the albumins, affording compounds which are not readily soluble (Davenport '97).

Ethyl alcohol, C_2H_5OH; 717, *3686*, 8602. Alcohol when contrasted with formaldehyde, is apparently non-toxic. One molecule of formaldehyde has powers of inhibiting germination of fungus spores equal to those of 2600 molecules of alcohol. The contrast in their killing powers is even greater, being as 1 : 4300! Yet, alcohol is a distinct poison to the protoplasm of plants (Tsukamoto '95), being used, in fact, quite extensively as a fixing

agent for tissues, and even more widely as a preservative. It inhibits germination in the mold spores used at an average concentration of $\frac{n}{1.3}$, and is fatal to all except Penicillium in $\frac{4n}{1}$. Five per cent. of the spores of Penicillium survived immersion in this concentration (17.6 per cent.) for 72 hours at 28° C. All, however, were killed by $\frac{8n}{1}$ which was the greatest concentration required to kill in the case of any agent tested.

The presence of alcohol in $\frac{n}{8}$ and $\frac{n}{16}$ concentration distinctly retarded germination of Sterigmatocystis and Botrytis. No retardation was noticed with Aspergillus or Œdocephalum. The latter, indeed, showed some evidence of acceleration of germination in $\frac{n}{16}$ and $\frac{n}{32}$ concentrations, but it was not sufficiently marked to be certainly stated. The stimulation of mycelial development and retardation of fruiting in $\frac{n}{4}$ was very marked with Aspergillus and Sterigmatocystis. Œdocephalum and Penicillium showed some stimulation of mycelial development and a slight retardation of fruiting in this concentration. Botrytis produced its heaviest mycelium in $\frac{n}{16}$ and $\frac{n}{32}$.

The change that a plant may undergo as it grows older, in the character of its election of foods is of great interest to physiologists (Davenport '99, p. 333). Duclaux ('89) found that while alcohol restrains or arrests germination in mold spores, it is made use of almost as abundantly as sugar by the adult plant. My results would seem to support this view. It may be possible, however, that alcohol acts as a stimulant rather than as a food, as is the case with zinc sulfate, and other non-nourishing compounds. Richards ('97) found that the addition of .0035 per cent. $Zn\,SO_4$ to a culture medium in which *Aspergillus niger* was growing doubled the dry weight of the mycelium. .008 per cent. $Zn\,SO_4$ similarly added to a flask culture of Botrytis caused a production of quadruple the normal weight of mycelium. We cannot suppose that the small amount of zinc present

in itself caused the greater growth by supplying nourishment, Zn not being a necessary or desirable element in a nutrient medium for fungi. Richards interpreted the function of the zinc to be that of a stimulant rather than a food. May it not be that alcohol performs a similar stimulating function, rather than that it produces an acceleration of growth by nourishment?

Whatever may be the correct explanation of the influence of alcohol on the development of the mold fungi, it seems to be demonstrated that the protoplasm of the molds is more sensitive in the conidial stage to the influence of this and most other deleterious agents than at any other stage in their development.

Potassium cyanid, KCN; 2.2, *25.6*, 77. Potassium cyanid in aqueous solution is very unstable. A solution of 24 per cent. KCN in pure water was prepared by the chemist, and on being used within three hours of titration gave the following critical points with Aspergillus and Penicillium:

Aspergillus in $\frac{n}{128}$ grew, in $\frac{n}{64}$ failed.

Penicillium in $\frac{n}{128}$ grew, in $\frac{n}{64}$ failed.

Ten days later this stock solution was again tested, having been kept in a dark cupboard at ordinary laboratory temperature in the meantime, with the following result:

Aspergillus in $\frac{n}{32}$ grew, in $\frac{n}{16}$ failed.

Penicillium in $\frac{n}{64}$ grew, in $\frac{n}{32}$ failed.

A solution in beet infusion containing $\frac{n}{8}$ $C\bar{N}$ was then made up from the stock solution and placed in the dark at a constant temperature of 28° C. for 10 days longer and again tested. The critical points were then as follows:

Aspergillus in $\frac{n}{16}$ grew, in $\frac{n}{8}$ failed.

Penicillium in $\frac{n}{16}$ grew, in $\frac{n}{8}$ failed.

From these data we learn that a 24 per cent. aqueous solution of KCN deteriorates so that at the end of ten days it has but little more than one fourth its former toxic value. Made up in beet infusion at $\frac{n}{8}$ concentration and kept ten days longer it retains but one eighth of its original toxic value. All cultures with KCN, reported in this paper, except those noted above, were made up within four hours of titration of the stock solution.

It will be seen by reference to the charts that KCN in solution has almost exactly nine times the toxic effect of ionic $\overset{+}{H}$. KCN in the concentrations used is quite highly ionized (Kohlrausch '79), but in trying to approximate the toxic value of the $C\overline{N}$ ion, the fact that a certain amount of hydrolysis takes place in aqueous solutions of this salt, with a corresponding formation of the deadly HCN, must not be overlooked. According to the data worked out by Shields ('93) and what we already know of the properties of HCN, approximately 15 per cent. of the total toxic value of these solutions must be attributed to the HCN present. This would give something under $8\overset{+}{H}$ as the value of the $C\overline{N}$ ion.

KCN retarded germination and early development in all forms. In this, as with many other agents, those cultures not greatly injured soon overcame the effect of the poison and grew and fruited normally. No marked retardation of fruiting nor unusual development of mycelium was noted. Sterigmatocystis, in so many cases highly resistant, proved equally sensitive with Œdocephalum, both being inhibited by $\frac{n}{128}$ and killed by $\frac{n}{64}$.

Kahlenberg and True ('96) found that towards Lupinus it has the value of $1\overset{+}{H}$ only. They also show that in the cases of potassium ferro- and ferri-cyanid the iron and $C\overline{N}$ radical form complex ions, the toxic value of which is far less than that of the $C\overline{N}$ ions.

Mercuric chlorid.—$HgCl_2$; 0.0258, *0.281*, 0.331. This proved the most fatal compound tested, leading silver nitrate by a narrow margin.

It is of interest to note that although only very slightly volatile at ordinary temperatures, and doubtless less so in aqueous solution, mercuric chlorid is sufficiently volatile even in dilute aqueous solution at 28°C. to be distinctly toxic. This was demonstrated by placing a few drops of a very dilute solution in the bottoms of cells containing hanging drops of pure beet infusion inoculated with mold spores. The germination of the spores was inhibited. Mycologists have frequently reported failure to germinate spores in cells which had been sterilized by rinsing in a dilute solution of $HgCl_2$. These failures were doubtless due to the volatile properties of this agent together with its extremely deadly character.

Botrytis proved particularly sensitive to this agent, $\frac{n}{65536}$ proving fatal. Penicillium failed to show its usual high relative resistance, being killed by $\frac{n}{4096}$, the same concentration as proved fatal to Aspergillus and Sterigmatocystis. Toward bacteria it is also extremely fatal, $\frac{n}{70000}$ in nutritive bouillon preventing the development of the splenic fever bacterium (Davenport '97, p. 14). The data regarding its influence on the higher plants are meager. Kahlenberg and True ('96) found $\frac{n}{6400}$ fatal to Lupinus, while it survived in $\frac{n}{12800}$. This is unexpectedly low, being in fact but double the toxic value of HCl. For the molds its average value will be seen to be over 800 times that of HCl.

Silver nitrate, $AgNO_3$; 0.0125, *0.375*, 0.375. Almost, if not altogether, as violent a poison as mercury, silver stands with it at the head of the list of toxic agents tested. Among the poisons for molds tested, it is comparable with mercury alone among the metals, and with the chromate and dichromate anions and formaldehyde only among the other agents. As is the case with bacteria (Davenport '97, p. 14) toward the molds silver is frequently a more violent poison than mercury. Of the five molds used Œdocephalum and Penicillium proved more susceptible to

silver, while Aspergillus and Botrytis were more susceptible to mercury. The fifth form, Sterigmatocystis, had an equal resistance to both. The extraordinarily small quantity of mercury required to kill Botrytis, however, left the honors with mercury as the more deadly agent.

A very striking contrast in specific resistances is afforded by Botrytis and Penicillium in solutions of these agents. One sixteenth the amount of $HgCl_2$ necessary to kill Penicillium was fatal to Botrytis. With $AgNO_3$ one fourth the concentration required to kill Botrytis was fatal to Penicillium. Or, putting it another way, $AgNO_3$ has eight times the toxic value of $HgCl_2$ toward Penicillium, while the exact converse is true with Botrytis, $HgCl_2$ being eight times as effective as $AgNO_3$ to this form. The low resistance of Penicillium to silver is quite striking, $\frac{n}{32768}$ proving fatal. In one other case only (H_2O_2) did Penicillium show a lower resistance than Botrytis.

Toward splenic fever bacteria gold is the only other metal comparable in toxic properties with mercury and silver (Davenport '97, p. 14). Toward phanerogams silver is much more toxic than mercury, $\frac{n}{102400}$ being fatal to Zea, and $\frac{n}{204800}$ to Lupinus (Heald '96, p. 152). At the concentrations used the $AgNO_3$ would be practically entirely ionized (Kohlrausch, '85).

Cadmium nitrate, $Cd(NO_3)_2$; 0.075, *6.1*, 24. Ranking closely with silver as a poison for the higher plants, cadmium proves to be very highly toxic to the mold fungi. Perhaps the most marked feature in the cultures with cadmium was the very wide range between the killing point and the point where development was only noticeably injured. It will be noticed that the ratio of its coefficient of injury to that of $HgCl_2$ is less than 3 : 1, while the ratio between their death points is 75 : 1. A second striking feature of the toxicity of cadmium is the great variation in the specific resistances of the different forms. $\frac{n}{4096}$ proved fatal to Botrytis, but $\frac{n}{32}$ was required to kill Sterig-

matocystis. Penicillium spores failed again to show their usually high resistance, $\frac{n}{256}$ proving fatal, a concentration in which the usually sensitive Œdocephalum actually germinated 95 per cent. and matured a few fruits.

Molisch ('94) was one of the first to record the toxic properties of cadmium to plants. He found $\frac{n}{33}$ fatal to Aspergillus when experimenting with various metals in an endeavor to find a substitute for calcium in nutrient media. $\frac{n}{64}$ proved fatal to the form of Aspergillus used by the writer.

At its average inhibiting concentration cadmium nitrate would be about 90 per cent. ionized (Grotrian, '83).

OXIDIZING AGENTS.

Potassium dichromate, $K_2Cr_2O_7$; 0.094, *0.3*, 1.25.

Potassium chromate, K_2CrO_4; 0.156, *0.4*, 2.25.

These salts at the dilutions at which they are effective are doubtless practically entirely ionized (Ostwald, '88).

As poisons for the molds they rank, as already mentioned, with formaldehyde, silver, and mercury. The anion of the dichromate, $\overline{Cr_2O_7}$ has a toxic value of about 770 $\overset{+}{H}$; that of the chromate 575 $\overset{+}{H}$. This may indicate some relation between their oxidizing powers and their toxicity.

The effects of these salts in concentrations permitting development of the fungi were very similar, and resembled that of H_2O_2. Retardation of germination in the cultures approaching the inhibiting point was noticed in all forms with both agents, but it was not nearly so well marked as it is in most cases. Another feature was the fact that every culture that germinated any spores developed some conidia within forty-eight hours.

Toward the higher plants these anions seem to be relatively much less toxic. Lupinus survives in a $\frac{n}{6400}$ solution of H_2CrO_4, the same concentration as permitted growth with HCl (Kahlenberg and True, '96). Toward the algæ (Loew, '93), however,

both these anions are strongly toxic, $\frac{n}{295}$ $K_2Cr_2O_7$ being fatal to Spirogyra in a few hours.

Hydrogen peroxid, H_2O_2; 38, *105*, 127. This agent had an effect on the molds very similar to that described for the chromates. With it, however, the characteristics given for the chromates were somewhat intensified. Germination was but slightly retarded in most forms in $\frac{n}{312}$ concentration, and Œdocephalum actually showed a higher percentage germinated in these cultures at four hours than in the checks. The difference, however, was not sufficient to establish the conclusion that the H_2O_2 accelerated germination. That this concentration accelerated early mycelial growth with this form was undoubtedly established. At four hours the average length of the germ tubes in $\frac{n}{312}$ concentration was 120μ as compared with 40μ in the checks. At seven hours they were 310μ and 115μ respectively. $\frac{n}{156}$, the limiting culture for this form, made the best mycelial development and matured the heaviest crop of conidia in the set. The characteristic already mentioned for the chromates regarding fruiting in the cultures was even more marked with this agent. Every culture that produced even the scantiest mycelium presently developed at least two or three all but normal conidiophores.

In regard to the action of this agent on other organisms, the data are meager and conflicting. Miquel ('83) places it third in disinfecting properties of all agents used by him. In his results it is rated above both $HgCl_2$ and $AgNO_3$, being given as antiseptic in dilution of 1 part to 20,000. This is certainly too high an estimate. Sternberg ('92) found it to have a comparatively low toxic value for bacteria. One in 1000 kills ordinary water bacteria, cholera, and typhoid (Altehofer '90). This would be about $\frac{n}{33}$, or a 3 to 4 per cent. solution of the ordinary 10-volume commercial article. It will be seen that this agrees fairly closely with its toxic properties for the molds, $\frac{n}{39}$

being fatal to Sterigmatocystis and $\frac{n}{78}$ to Œdocephalum. The others are more resistant. It is, however, more toxic to algæ (Bokorny, '86) than to molds, and Ciliata are even more susceptible. Paneth ('89) found a .005 per cent. solution to be the limiting line for the latter.

Commercial preparations of H_2O_2 vary very greatly in the amount of H_2O_2 in solution. A true ten-volume solution should yield, when fully decomposed, ten volumes of O, and should contain by weight 3.04 per cent. H_2O_2. The preparation used in this study although "fully guaranteed," etc., contained but 2.59 per cent. H_2O_2 on being tested.

SULFATES OF THE STRONGLY-TOXIC METALS.

These salts are arranged in the order of their toxic properties towards molds in the following list:

Nickelous sulfate, $NiSO_4$; 4.8, *33.6*, 1155.
Cobaltous sulfate, $CoSO_4$; 6, *57.6*, 389.
Ferrous sulfate, $FeSO_4$; 14.4, *115*, 2150.
Copper sulfate, $CuSO_4$; 8.4, *131.2*, 582.
(Copper nitrate, $Cu(NO_3)_2$; 8.4, *134*, 634.)
Zinc sulfate, $ZnSO_4$; 26.4, *602*, 3072.

The data regarding the ionizations of these salts are rather meager. They are, however, not greatly different in ionization at similar concentrations. This is about 40 per cent. to 44 per cent. at $\frac{n}{20}$ concentration (Whetham, '95, pp. 218–276).

Nickelous sulfate.—The different molds exhibited more variations in their specific resistance to this agent in regard to the death point than was observed with any other. $\frac{n}{128}$ proved fatal to Botrytis, while Aspergillus failed to lose its vitality in a normal solution (containing over 13 per cent. anhydrous $NiSO_4$) for 48 hours. Much less variation was shown in its inhibiting powers. Aspergillus and Penicillium germinated in $\frac{n}{64}$; $\frac{n}{256}$ inhibited Botrytis. The fact that 32 times the strength

which inhibited the spores of Aspergillus failed to kill them was nowhere else paralleled with this form and but once surpassed by Penicillium.

Cobaltous sulfate stands in second place in this group as an inhibiting agent, but, as will be seen, it is relatively much more powerful as a disinfectant. Penicillium, however, showed its usual high powers of resistance in this respect. Inhibited by $\frac{n}{64}$, $\frac{n}{2}$ was required to kill.

Ferrous sulfate.—Iron, a necessary element for the nutrition of the molds (Molisch, '94) in common with all other plants, in excess proves to be a very strongly toxic agent, surpassing in this respect that king of modern fungicides, copper. With the exception of nickel as noted above, iron showed a greater difference between the average concentration required to inhibit the spores and the concentration required to kill than any other agent. Botrytis, as usual, showed less variation in this respect than the other forms, but even with it one eighth the fatal concentration inhibited germination. Œdocephalum showed the greatest resistance to this agent both as regards inhibition of germination and killing of the spores. This was the only agent with which it had a higher specific resistance than any other form.

Copper sulfate and nitrate.—These salts proved to be quite similar in toxic properties, as may be noticed by a glance at the diagrams, p. 312. The nitrate, however, is much more highly ionized at the critical concentrations; hence we judge that the un-ionized molecule $CuSO_4$ has a toxic value not greatly different from ionic $^{+}Cu^{+}$.

Penicillium, although inhibited by $\frac{n}{64}$ $Cu(NO_3)_2$ and $\frac{n}{128}$ $CuSO_4$, required a $\frac{n}{1}$ concentration in both cases to kill the spores. This certainly shows great resistance to these agents as compared with the other molds. It, however, appears insignificant when contrasted with many of the results gotten by other workers. $\frac{n}{128}$

$CuSO_4$, which effectually inhibited germination in the form used by the writer, contains about 0.1 per cent. $CuSO_4$. De Seynes ('95) reports growing cultures of *Penicillium glaucum*, gotten from different sources, in solutions containing 2 to 9.5 per cent. $CuSO_4$. Cultures grown on the stronger concentrations bore red spores. Pfeffer ('81) reports finding Penicillium growing on a concentrated solution of $CuSO_4$. Manasein (*fide* Loew '93) finds from his experiments that this salt must be present in a .25 per cent. concentration before it has any appreciable effect on this fungus. Others might be quoted, but sufficient has been said to indicate the possibilities yet to be investigated of the acclimatization of fungi (and other plants) to chemical agents (Davenport and Neal, '96).

Zinc sulfate.—Inasmuch as zinc chloride is used very extensively for impregnating railroad ties to prevent attacks of wood-destroying fungi (Roth, '95), it was a surprise to find it having so low a toxic value, particularly when it is recalled that one of the molds tested, Penicillium, is one of the enemies of the wooden ties (Ward, '98). Koch ('81) finds the chlorid and the sulfate to have practically the same disinfecting power. Towards Aspergillus we may say that zinc is non-toxic, the spores surviving an immersion of 48 hours in a $\frac{2n}{1}$ (27 per cent. anhydrous $ZnSO_4$) concentration. In a $\frac{n}{2}$ concentration (7 per cent.) 25 per cent. of the spores germinated and grew slowly. The mycelium produced was very irregular and closely septate.

Strychnin sulfate, $C_{21}H_{22}N_2O_2H_2SO_4$. This alkaloid, the only one experimented upon, was dissolved in the slightly acid beet infusion until a saturated solution was obtained. This was found to have a content of 4.31 per cent. strychnin sulfate. This in terms of a normal solution would be about $\frac{n}{7}$, a normal solution of this substance requiring over 30 per cent. on account of its very large and heavy molecule.

Sterigmatocystis grew and fruited normally in this saturated solution, although germination and early growth were retarded.

Aspergillus and Œdocephalum also grew and fruited, but the cultures were much behind the checks. Penicillium was inhibited by $\frac{n}{28}$, but was not killed by the saturated solution. Botrytis was also inhibited by $\frac{n}{28}$, and was killed by $\frac{n}{14}$. That the solution used was completely saturated was shown by the appearance of numerous microscopic crystals in some of the hanging-drops which were exposed for a few moments to the air, the evaporation from the culture medium causing some of the strychnin to crystallize out. The molds, however, continued to thrive in these cultures, their hyphæ growing among the crystals.

Of its effect on plants in general we have few data. Davenport ('97) mentions that it kills the protoplasm of Drosera tentacles, and hinders the development of peas, corn, and lupines. The injurious concentrations, however, are not mentioned. Much interesting work has been done on Protozoa (Schürmayer '90) by various workers. The results of these studies as well as those presented here for the molds are in harmony with the theory of Loew ('93) that the action of alkaloids is chiefly confined to the plasma of the ganglion cells. Fungi and bacteria having no differentiation of nerve protoplasm are practically unharmed by this agent.

Potassium iodid, bromid, and chlorid.—These salts proved to have a very low toxic value. A complete series of cultures with the five molds was made up with the iodid only. Its coefficients were determined to be 384, *2457*, and 4915. $\frac{n}{1}$ inhibited all except Aspergillus, $\frac{2n}{1}$ was fatal to all except Penicillium. As the potassium salts of the haloid acids are all quite highly ionized, an attempt was made to determine the relative toxic properties of the *ionic* halogen elements. Aspergillus and Œdocephalum were used. To these molds ionic $\bar{I}$ proved doubly toxic as compared with $\bar{Cl}$. $\bar{Br}$ occupied an intermediate position, being very slightly more toxic than ionic $\bar{Cl}$.

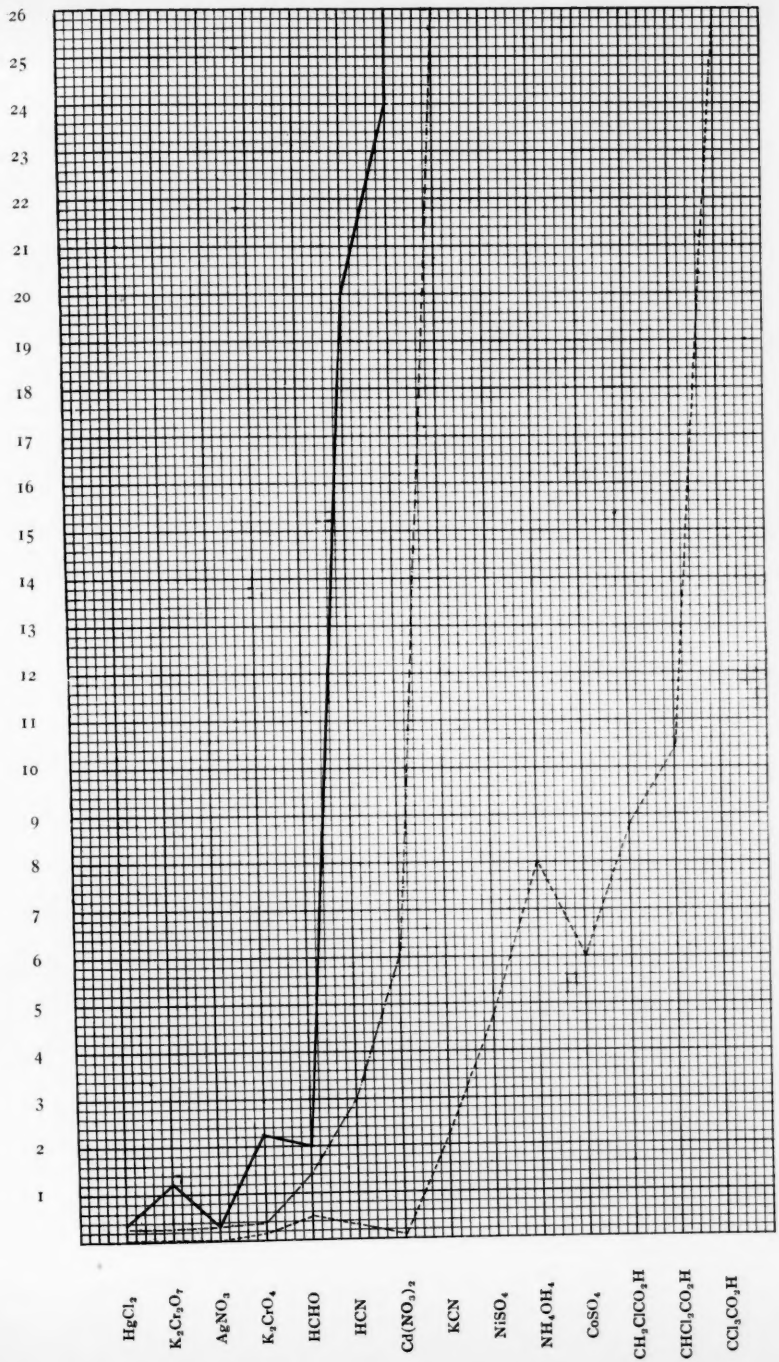
Sodium salicylate $C_6H_4{<}^{OH}_{COONa}$; 24, *182*, 182. It was

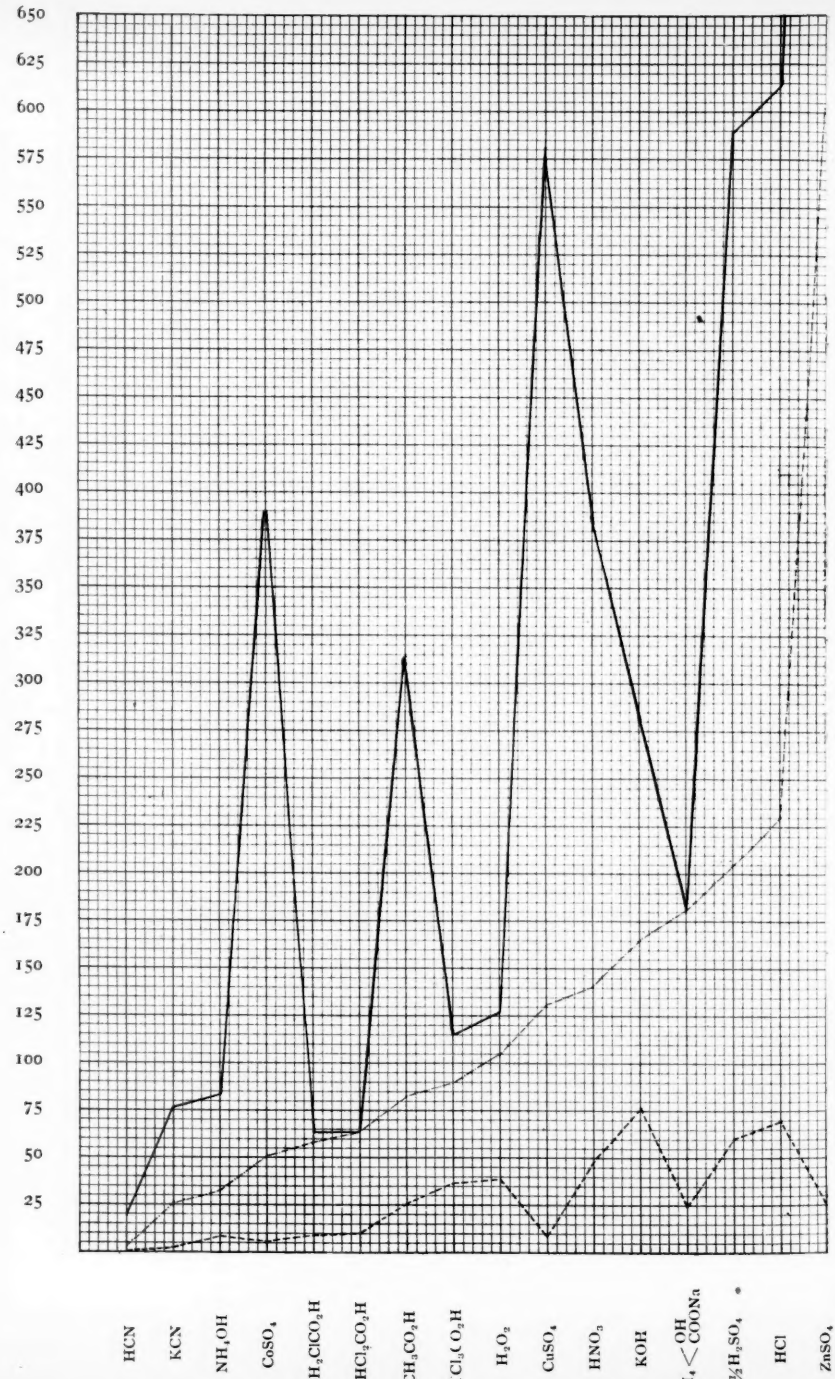
thought desirable to test this salt on account of its wide use as a preservative in laboratories and elsewhere. It proved somewhat more toxic than HCl, but not so fatal as HNO_3. Œdocephalum was quite susceptible to its influence, $\frac{n}{128}$ being fatal. It is not, however, of much value as a disinfectant, over 1 per cent. being necessary to prevent the development of molds.

In the following table the various agents are arranged in the order of their toxic properties as shown by their powers of inhibiting germination of the spores of the five species of molds used. The fifth column gives in round numbers the number of molecules of each substance required to produce an inhibiting effect equal to that *of one molecule of mercuric chlorid.* The coefficients have the usual value of x in the expression, $\frac{x}{2048}$ of $\frac{n}{1}$.

TABLE III.

Agent	Formula	Coefficient of injury	Coefficient of inhibition	Coefficient of death-point	Ratio
Mercuric chlorid	$HgCl_2$	.026	.281	.331	1.
Potassium dichromate	$K_2Cr_2O_7$	.094	.3	1 25	1.1
Silver nitrate	$AgNO_3$	.013	.375	.275	1.3
Potassium chromate	K_2CrO_4	.156	.4	2.25	1.4
Formaldehyde	HCHO	.553	1.43	2.	5.
Hydrocyanic acid	HCN	.365	3.	20.	11.
Cadmium nitrate	$Cd(NO_3)_2$	.075	6.1	24.	22.
Potassium cyanid	KCN	2.2	25.6	77.	91.
Nickelous sulfate	$NiSO_4$	4.8	33.6	1155.	120.
Ammonium hydroxid	NH_4OH	8.	51.	83.	182.
Cobaltous sulfate	$CoSO_4$	6.	57.6	389.	206.
Monochloracetic acid	CH_2ClCO_2H	8.8	58.	64.	207.
Dichloracetic acid	$CHCl_2CO_2H$	10.4	64.	64.	229.
Acetic acid	CH_3CO_2H	25.6	83.	314.	296.
Trichloracetic acid	CCl_3CO_2H	37.	90.	115.	321.
Hydrogen peroxid	H_2O_2	38.	105.	127.	375.
Ferrous sulfate	$FeSO_4$	14.4	115.	2150.	411.
Copper sulfate	$CuSO_4$	8.4	131.	582.	468.
Copper nitrate	$Cu(NO_3)_2$	8.4	134.	634.	479.
Nitric acid	HNO_3	48.	141.	384.	503.
Potassium hydroxid	KOH	19. / 77.	166.	282.	593.
Sodium salicylate	$C_6H_4{<}^{OH}_{CO_2Na}$	24.	182.	182.	650.
Sulfuric acid	$\frac{1}{2}H_2SO_4$	61.	205.	589.	732.
Hydrochloric acid	HCl	70.	230.	614.	821.
Zinc sulfate	$ZnSO_4$	26.4	602.	3072.	2150.
Strychnin sulfate	$C_{12}H_{22}N_2O_2H_2SO_4$	179.			
Potassium iodid	KI	384.	2457.	4915.	8775.
Ethyl alcohol	C_2H_5OH	717.	3686.	8602.	13164.


26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
HgCl2
K2Cr2O7
AgNO3
K2CrO4
HCHO
HCN
Cd(NO3)2
KCN
NiSO4
NH4OH4
CoSO4
CH2ClCO2H
CHCl2CO2H
CCl3CO2H


650
625
600
575
550
525
500
475
450
425
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
HCN
KCN
NH4OH
CoSO4
CH2ClCO2H
CHCl2CO2H
CH3CO2H
CCl3CO2H
H2O2
CuSO4
HNO3
KOH
C6H4<OH COONa
½H2SO4
HCl
ZnSO4

Diagrams IX and X are simply a graphic representation of the more important features of this table. The values of the abscissæ in each case $= x$ in the expression $\frac{x}{2048}$ of a normal solution.

SUMMARY.

1. Fungi are in general much more resistant to most deleterious agents than the higher plants. In the case of the mineral acids a concentration of from two to four hundred times the strength fatal to the higher plants is required to inhibit the germination of mold spores under favorable conditions.

2. Different species of fungi present great differences of resistance to many agents. Of the agents tested in this study, $NiSO_4$ permitted the greatest specific variation and dichloracetic acid the least.

3. Particular forms of the same species present very different powers of resistance, depending probably on previous environment.

4. Individual spores taken from the same pure culture often present considerable variation in resistance.

5. The five forms used were found to be increasingly resistant to the toxic action of acids in the following order: Œdocephalum, Botrytis, Penicillium, Aspergillus, and Sterigmatocystis.

6. Toward all the agents tested they proved increasingly resistant in the following order: Botrytis, Œdocephalum, Penicillium, Sterigmatocystis, Aspergillus.

7. Œdocephalum and Botrytis, although on the average the most susceptible to the various agents, have great specific resistances to certain agents. See $FeSO_4$, KI, and alcohol.

8. Tests made with media not well suited for the normal development of the fungi tested will give a correct value for the *killing concentration*, but the data regarding the point of inhibition of germination are not of value.

9. Tests of the toxic value of solutions are unreliable when made in hanging-drop cultures where water was used in the

bottom of the cell instead of a solution similar in composition to that forming the hanging-drop. The variation in the toxic value indicated from the actual value will depend on the *vapor pressures* of the solutions used. Volatile—especially highly volatile—and hygroscopic solutions will show the greatest error.

10. Many deleterious agents which at certain concentrations retard germination and early growth, afterwards cause a great acceleration of mycelial development in these retarded cultures. This abnormal development of mycelium is usually accompanied by retardation of fruiting.

11. In the conidial stage the protoplasm of molds is in general more sensitive to the action of deleterious agents than at any other stage in their life history.

12. The effect of the different deleterious agents on the appearance of the mycelium is very varied and often quite characteristic.

13. One is not justified in drawing any conclusions as to the killing powers of an agent from its effect in inhibiting the germination of the spores.

14. The hydroxyl group $\bar{O}H$ is rather more toxic to molds than ionic $\dot{H}$.

15. The toxic value of the halogens, Cl, Br, and I, in the *ionic* state, increases somewhat in the order of increasing atomic weight.

16. The cyanogen radical is a very powerful poison to fungi, KCN having nine times the toxic value of HCl.

17. Mercuric chlorid and silver nitrate are about equally toxic to molds; and are followed in toxic properties by potassium dichromate and chromate, and formaldehyde.

18. Strychnin and hydrocyanic acid, both extremely fatal poisons to the higher animals, and both supposed to act on the protoplasm of the nerve cells, react very differently toward fungi. To the molds strychnin is practically non-toxic, whereas hydrocyanic acid is a very violent poison.

19. Nickel, cobalt, iron, copper, and zinc inhibit mold spores in the order named. Zinc is much less toxic than the others.

20. That an element is necessary for the nutrition of a plant does not indicate whether it would or would not be a poison in greater concentration. See iron, oxygen, etc.

21. That an element is not necessary for the normal development of a plant does not imply that it would be injurious even in relatively great concentration. See chlorin, calcium, etc.

22. The ionization of the molecule of electrolytes in aqueous solution has a very important bearing on the study of the physiology of poisons. It is of especial value in determining the element or group of elements in a compound to which its toxic properties are to be attributed.

23. In this study no new evidence has been adduced supporting the theory that the chemical activities of a substance are due wholly or chiefly to the ionized portion.

24. Evidence has been adduced to the effect that in the case of several acids ionization *lessens* the chemical activities toward the substances involved in the life processes of the plant.

25. In the case of the eight acids investigated six were found to be much more toxic in the molecular form than after ionization. The toxic properties of the un-ionized molecules vary from approximately 2.8 times that of ionic $\overset{+}{H}$ in the case of acetic acid to 76.6 times that of $\overset{+}{H}$ in hydrocyanic acid.

26. The substitution of Cl for H in the acetic acid radical has a double effect. In the first place it increases the toxicity of the un-ionized molecules to a greater or less extent depending on the number of H atoms so replaced. In the second place, it increases the ionization of the acid. The amount of the ionization is also dependent on the amount of H so replaced, being greatest, as are the toxic properties of the whole molecules, when all three H atoms have been replaced by Cl.

27. These two factors to a great extent counterbalance each other. Which has the greater influence in any given solution depends altogether on the concentration, the increased toxicity of the molecules having the predominating influence at the greater concentrations, and the ionization being more effective at the greater dilutions.

28. At the concentrations inhibiting fungus spores mono- and dichloracetic acids are more influenced by the increased toxic properties of the molecule, and trichloracetic by the ionization. The former in $\frac{n}{35}$ and $\frac{n}{32}$ concentration are respectively increased in toxicity 40 per cent. and 30 per cent. over the original acetic. Trichloracetic, on the contrary, at $\frac{n}{22.8}$ suffers a reduction of 10 per cent. in toxic properties as compared with the original acetic.

29. The anions of the mineral acids, HCl, HNO_3, and H_2SO_4, have a low toxic value for fungi, having less than one thirty-second that of ionic H.

In conclusion I wish to acknowledge my indebtedness to Dr. B. M. Duggar, instructor in plant physiology, and Professor George F. Atkinson, professor of botany in Cornell University, for much valuable advice and assistance, and constant encouragement. My best thanks are also due to Professor W. D. Bancroft and Mr. A. L. Knisely of the chemical department for much help and information on the chemical aspects of the work.

BOTANICAL LABORATORY, CORNELL UNIVERSITY.

BIBLIOGRAPHY.

ACTON, E. H. ('89): The assimilation of carbon by green plants from certain organic compounds. Proc. Roy. Soc. of London **46**: 118–121. 1889.

ALTEHOFER ('90): Über die Disinfektionskraft von Wasserstaffsuperoxyd auf Wasser. Central. f. Bakteriol. **8**: 129. 1890.

ARRHENIUS ('83): Recherches sur la conductivité galvanique des électrolytes. Stockholm. 1883. Abstract in B. A. Report **1886**: 357.

ARTHUR, J. C. ('97): Formalin for prevention of potato scab. Bull. of Purdue Univ. Exp. Stn. 65: 1897.

BOKORNY, T. ('86): Das Wasserstoffsuperoxyd und die Silberabscheidung durch actives Albumin. Jahrb. f. wiss. Bot. **17**: 347–358. 1886.

——— ('88): Über die Einwirkung basischer Stoffe auf dasle bende Protoplasma. Jahrb. f. wiss. Bot. **19**: 206–220. 1888.

CLARK, J. F. ('99): Electrolytic dissociation and toxic effect. Jour. Physical Chem. **3**: 263–316. 1899.

COHN, F. ('94): Formaldehyd und seine Wirkungen auf Bacterien. Bot. Central. **57**: 3–6. 1894.

DAVENPORT, C. B., and NEAL, H. V. ('96): On the acclimatization of organisms to poisonous chemical substances. Arch. f. Entwick. d. Organismen **2**: 564–583. 1896.

DAVENPORT, C. B. ('97): Experimental morphology, Part I. 1897.

——— ('99): Experimental morphology, Part II. 1899.

DE SEYNES, J. ('95): Résultats de la culture der Penicillium. Bull. de la Soc. Bot. de Fr. **42**: 451–455, and 482–485.

DETMOOR, J. ('94): Contribution à l'étude de la physiologie de la cellule (interdépendance functionnelle du protoplasm et du noyau). Arch. de Biol. **13**: 163–244. 1894.

DUCLAUX, E. ('89): Sur la nutrition intracellulaire. Ann. de l'Inst. Pasteur **3**: 97–112. 1889.

GROTRIAN, O. ('83): Das electrische Leitungsvermögen einiger Cadmium- und Quicksilbersalze in wässerigen Lösungen. Wied. Annal. **18**: 176–213. 1883.

HEALD, F. D. ('96): On the toxic effect of dilute solutions of acids and salts on plants. Bot. Gaz. **22**: 125–153. 1896.

KAHLENBERG and TRUE, R. H. ('96): On the toxic action of dissolved salts and their electrolytic dissociation. Bot. Gaz. **22**: 81–124. 1896.

KOCH ('81): Über Desinfektion. Mitth. aus dem k. Gesundheitsamte **1**: 1–49. 1881.

KOHLRAUSCH, F. ('79): Das electrische Leitungsvermögen der wässerigen Lösungen von den Hydraten und Salzen der leichten Metalle, sowie von Kupfervitriol, Zinkvitriol und Silbersalpeter. Wied. Annal. **6**: 149–210. 1879.

——— ('85): Über das Leitungsvermögen einiger Electrolyte in äusserst verdünnter wässeriger Lösung. Wied. Annal. **26**: 161–226. 1895.

KOZLOWSKI, W. M. ('99): The primary synthesis of proteids in plants. Bull. Torr. Bot. Club **26**: 35–57. 1899.

KRÖNIG and PAUL ('97): Die chemischen Grundlagen der Lehre von der Giftwirkung und Desinfektion. Zeit. f. Hygiene und Infect. **25**: ——. 1897.

LEVY, A. ('95): Die Multirotation der Dextrose. Zeit. phys. Chem. **17**: 301–324. 1895.

LOEW, O., and BOKORNY, T. ('87): Chemisch-physiologische Studien über Algen. Journ. f. prakt. Chem. **36**: 272–291. 1887.

LOEW, O. ('88): Physiologische Notizen über Formaldehyd. Sb. Ges. f. Morpol. u. Physiol. München **4**: 39–41. 1888.

——— ('93): Ein naturalisches System der Gift-Wirkungen. 1893.

MASSART, J. ('93): Sur l'irritabilité des Noctiluques. Bull. Sci. France et Belg. **25**: 59–76. 1893.

MIGULA, W. ('90): Über den Einfluss stark verdünnter Säurelösungen auf Algenzellen. Inaug. Diss., Breslau, 1889. Abs. in Bot. Central. **41**: 207. 1890.

MIQUEL ('83): Les organismes vivants de l'atmosphere. Paris, 1883. Also Bull. gen. de Thérap. **107**: 80–95. 1884.

MOLISCH, H. ('94): Die mineralische Nahrung der niederer Pilze. Sitz. d. k. Akad. d. wiss. Wien. Math.-naturw. Cl. **103**: Abth. I. 1894.

OSTWALD, W. ('85): Electrochemische Studien. Journ. f. prakt. Chem. **32**: 304. 1885.

——— ('86): Electrochemische Studien. Journ. f. prakt. Chem. **33**: 353–370. 1886.

——— ('88): Über Chromsäure. Zeit. phys. Chem. **2**: 78–82. 1888.

——— ('89): Über die Affinitätsgrossen organischer Säuren und ihre Beziehungen zur Zusammensetzung und Konstitution derselben. Zeit. phys. Chem. **3**: 170–197. 1889.

——— ('91): Lehrbuch der allgemeinen Chemie **1**. 1891.

PANETH, J. ('89): Über das Verhalten von Infusorien gegen Wasserstoffsuperoxyd. Central. f. Physiol. **3**: 377–380. 1889.

PFEFFER W. ('81): Pflanzenphysiologie **2**. 1881.

——— ('95): Über der Election organischer Nährstoffe. Jahrb. f. wiss. Bot. **28**: 205–268. 1895.

RICHARDS, H. M. ('97): Die Beeinflussung des Wachsthums einiger Pilze durch chemische Reize. Jahr. f. wiss. Bot. **30**: 665–688. 1897.

ROTH, F. ('95): Timber. U. S. Dept. of Agr. Div. of Forestry, Bulletin 10.

SCHÜRMAYER, C. B. ('90): Über den Einfluss äusserer Agenten auf einzellige Wesen. Jena, Zeitschr. **24**: 402–470. 1890.

SHIELDS, J. ('93): Über Hydrolyse in wässerigen Salzlösungen. Zeit. phys. Chem. **12**: 167–187. 1893.

STEVENS, F. L. ('98): The effect of aqueous solutions upon the germination of fungus spores. Bot. Gaz. **26**: 377–406. 1898.

STERNBERG, G. M. ('92): Manual of Bacteriology, 1892.

TSUKAMOTO, M. ('95): On the poisonous action of alcohols upon different organisms. Jour. Coll. Sci. Japan **7**: 269–281. 1895.

WARD, H. M. ('98): Penicillium as a wood-destroying fungus. Ann. of Bot. **12**: 565–566. 1898.

WHETHAM, W. C. D. ('95): Solutions and electrolysis. Cambridge. 1895.

STUDIES IN CRATÆGUS. I.

C. D. Beadle.

Few genera so widely distributed in the United States have been so poorly interpreted by American botanists as the genus Cratægus. In Europe there exists a better understanding of a number of American forms, a knowledge gained almost wholly from cultivated specimens, but it must be evident to any student of these interesting plants that all of the descriptions published up to the present time fall short of embracing the forms growing in almost any section of the country. My attention was first drawn to the thorns about ten years ago, when I attempted to raise many thousands of young plants from seeds gathered in the southern Alleghany region. Making no attempt to propagate other than thrifty plants of the well-known and widely recognized species, I was perplexed to find a nursery of the most diverse forms under almost every label. Low and bushy plants with dark foliage stood in bold contrast with tall and fastigiate individuals with leaves of different tint and outline. No explanation seemed more reasonable than that some careless gardener had mixed the seeds so painstakingly collected from fine, healthy individuals, and with a determination that more care should be exercised in succeeding attempts, the matter was dropped. The next autumn the sowing was most carefully done, and while the fruits and seeds did not all look quite alike, it was easily demonstrated that the species recognized in our botanical field-books were not confounded. The results of this seeding were even more confusing than the first, as the seeds were gathered from wider fields. And thus the evidence accumulated each year, until, almost unconsciously, I commenced to separate the forms as they grew and the seeds as they were gathered. This solution was complete, and as the oldest seedlings are now bearing the kinds of fruits earlier recognized as strange, the publication of

new species is fully justified. In this, and other papers which will appear as suitable material accumulates, I propose to deal with new forms coming to my attention, and to characterize the published species, with which are now confounded others with constant and widely different features.

Cratægus Biltmoreana, n. sp.—A branching shrub, 1–5^{m} tall, growing in dry or rocky woodlands: flowers, which appear when the leaves are almost fully grown, white, 2–2.5^{cm} in diameter when expanded, produced in simple, pubescent, 3–7-flowered corymbs with lanceolate, pectinately-glandular, caducous bracts; they are borne on strict, pubescent pedicels which vary from 7^{mm}–2.5^{cm} in length and open in the vicinity of Biltmore, N. C. (type locality), about the twentieth of May: calyx obconic, pubescent or tomentose on the outside, with lanceolate, dentate or pectinate, glandular lobes about 5^{mm} long which are reflexed after anthesis: petals broadly-obovate or nearly orbicular in outline, 8–12^{mm}, contracted near the base into short claws: stamens 10, shorter than the petals; the anthers pale yellow: styles 3–5, shorter than the stamens, surrounded at the base with pale hairs: fruit, which ripens and falls at the end of September or early in October, yellow, greenish-yellow or sometimes orange, the parts exposed to the sun being rosy-cheeked or diffused with red, containing from 3–5 nutlets; they are depressed-globose, bluntly angled, 10–15^{mm} broad, 10–12^{mm} high, the cavity broad, 3–5^{mm}, and deep, 2–3^{mm}, surrounded by the calyx lobes and portions of the filaments: nutlets thick walled, 5–7^{mm} in greatest diameter, 3–5^{mm} measured dorsoventrally, a volume of 125^{cc} containing about 1858 thoroughly cleaned, dry seeds; they are deeply grooved on the back and display a prominent ridge near the middle, the inner faces being nearly plane: leaves 2–6^{cm} wide, 3–10^{cm} long including the petiole, or occasionally larger, ovate, or round-ovate, acute at the apex; rounded, truncate or on vigorous shoots subcordate, but usually wedge-shaped at the base and prolonged into a slightly winged or margined petiole 1–3^{cm} long and bearing, as does the extreme base of the leaf, a few dark-colored stalked

glands; borders acutely incised, or slightly 5–9-lobed and sharply and irregularly serrate to near the base; they are thin and membranaceous at flowering time, becoming firmer and thicker with age, harshly, though rather inconspicuously pubescent on both surfaces throughout the vegetating season, bright green on the upper surface, pale beneath, the prominent veins being disposed in 4–6 pairs: spines stout, 2–5^{cm} long on the branches, slightly curved, dark chestnut-brown on the new and gray on the old wood: bark of the main stem reddish-brown, slightly fissured and broken into many small, persistent, ashy-gray scales; that of the branchlets chestnut- or reddish-brown, or gray, sprinkled with small, pale lenticels: buds almost globular, bright reddish-brown.

Cratægus Biltmoreana is distributed from North Carolina, northern Alabama, and eastern Tennessee to Virginia and Pennsylvania. It has been usually confounded with and preserved in herbaria under the name *C. mollis* (T. & G.) Scheele,[1] from which, or any form now resting under this name, the Biltmore thorn may be known by its smaller size, simple corymbs, later time of blossoming, and by the color and texture of the fruit. The type material is preserved in the Biltmore Herbarium.

Cratægus Sargenti, n. sp.—An intricately branched tree, seldom more than 6^{m} tall, or more frequently a large shrub 2-5^{m} in height, with one or several stems: the bark of the trunk ashy-gray or light brown, slightly fissured and broken into many thin plate-like scales, or nearly smooth with scattered patches of appressed, small scales: branches spreading or ascending, armed with straight or curved, simple or branched, dark chestnut-brown or gray spines 2.5-7^{cm} long; they are intricately divided into numerous, short branchlets which are clothed with dark reddish-brown bark and marked by small round or elongated pale lenticels, forming a narrow, or occasionally round or flat-topped head: buds globular, bright reddish-brown: flowers, which appear about the first of May in the vicinity of Valley Head, Alabama, and when the leaves are almost fully grown, disposed

[1] Linnæa **21**: 569. 1848.

in a few- (mostly 3-) flowered, more or less pubescent, simple corymbs: lateral pedicels longer than the intermediate ones, 1.5–3.5^{cm} long, more or less pubescent or pilose: calyx obconic, pubescent, the segments glandular-serrate, 6–9^{mm} long, persistent or nearly so: corolla white, the divisions nearly round or a little broader than long: stamens normally 20, 5–7^{mm} long: pistils 3–5, surrounded at the base with pale hairs: fruit, which ripens and falls after the middle of September, globose or depressed-globose, 10–13^{mm} broad, 10–12^{mm} high, yellow, orange-yellow or flushed with red, the flesh thin and firm; cavity 3–5^{mm} broad and nearly as deep, surrounded by the remnants of the stamens: nutlets 3–5, but usually 4, hard and bony, the walls thick, 7–9^{mm} long, 4–6^{mm} measured dorso-ventrally, with the back ridged and grooved and the lateral faces nearly plane: leaves thin to subcoriaceous, sparsely pubescent when young, soon glabrous, yellowish-green on the upper surface, paler below and displaying 5–7 pairs of prominent veins; they are ovate, ovate-lanceolate or round-ovate, 2.5–12^{cm} long, 1–6^{cm} wide, or occasionally larger on vigorous shoots, acute at the apex, rounded or abruptly contracted at the base into a margined or winged, slightly glandular petiole, 5^{mm}–3.5^{cm} long, the borders irregularly and doubly serrate and incisely lobed and the serratures minutely glandular-tipped: stipules linear to linear-lanceolate, glandular, or on strong shoots foliaceous, lunate, glandular-serrate, caducous.

Cratægus Sargenti is a remarkably distinct and showy species, especially in the autumn when the foliage assumes many lively tints of red and yellow. It inhabits the rocky woods and bluffs, or occasionally the rich, deep soil of the mountainous regions of northwestern Georgia, northern Alabama (extending as far south as Birmingham), and southeastern Tennessee. The species belongs to an interesting and very natural group of several distinct species of which no type has, so far as I have observed, been published. Many specimens of the related forms are preserved in herbaria under the names *C. rotundifolia*, *C. glandulosa*, *C. coccinea*, etc., titles which are, when correctly applied, associated with widely different plants.

I take pleasure in naming the species in honor of Professor C. S. Sargent, Director of the Arnold Arboretum of Harvard University, who first called my attention to specimens collected by him near Rome, Georgia, in April 1899. The type material, which I had the opportunity of selecting from thousands of examples near Valley Head, Alabama (type locality), is preserved in the Biltmore Herbarium.

Cratægus Boyntoni, n. sp.—A tree seldom more than 6^{m} in height, or more frequently a large branching shrub, $2–4^{m}$ tall, frequenting the banks of streams and even the shallow, dry soil of old fields and upland woods: flowers, which expand about the tenth of May in the vicinity of Biltmore, N. C. (type locality), and when the leaves are almost fully grown, $1.75–2.25^{cm}$ in diameter, produced in short, glandular-bracteate, 4–10-flowered corymbs: pedicels $7^{mm}–1.5^{cm}$ long, glabrous, bearing one or two glandular or pectinately-glandular bractlets: calyx obconic, smooth, the divisions acute, glandular serrate, $4–6^{mm}$ long: petals white, nearly orbicular, or a little broader than long, with a short and broad claw at the base, $9–12^{mm}$ in diameter: stamens 10, $6–9^{mm}$ long, the anthers light yellow: pistils 3–5, surrounded at the base with pale hairs: fruit dull, yellowish-green, flushed with russet-red, depressed-globose, angled, $10–14^{mm}$ high, $12–16^{mm}$ broad, ripening and falling early in October: nutlets 3–5, hard and bony, $6–8^{mm}$ long, $4–5^{mm}$ measured dorso-ventrally, the back ridged and grooved and the lateral faces nearly plane, a volume of 125^{cc} containing about 1293 thoroughly clean and dry seeds: leaves at first membranaceous, becoming subcoriaceous with age, yellowish-green on the upper, paler on the lower surface, glabrous, or with a few scattered hairs along the midrib and larger veins, which are disposed in 4–7 pairs; they are broadly ovate or oval in outline, acute at the apex, rounded or narrowed at the base and prolonged into a margined, glandular petiole $1–2.5^{cm}$ long, or on vigorous shoots deltoid-ovate and truncate or subcordate at the base; the borders are sharply and irregularly serrate, doubly serrate or incisely 5–7-lobed, the serratures minutely gland-tipped: stipules linear, glandular, caducous, or on strong

shoots foliaceous, lunate, glandular-serrate: trunk, which is 2–3^{m} long and 1–2^{dm} in diameter, and occasionally armed with gray, branched spines, covered with ashy-gray bark, not infrequently tinged with brown, or in the shade of the forest dark-gray, slightly fissured and broken into many small, plate-like scales: branches stout, ascending, armed with dark, chestnut-brown or gray, straight or slightly curved spines, 3–7^{cm} long, or larger, the bark close and smooth, dark-gray or brown: branchlets smooth, the bark dark reddish-brown, sprinkled with small, round or elongated, pale lenticels, the whole forming a narrow or occasionally round or flat-topped tree, or a much-branched oval or pyramidal shrub.

Cratægus Boyntoni is distributed from Georgia, Alabama, and Tennessee to Virginia, Pennsylvania, and Delaware, and will doubtless be found to extend over a broader area when better known. It is closely related to *C. Sargenti*, above proposed, but may be separated by the numerous-flowered, glabrous corymbs, shorter pedicels, and fewer stamens, and by the different habit of growth. Many specimens are preserved in herbaria, the greater part of which are also labeled *C. coccinea*, *C. glandulosa*, or *C. rotundifolia*. My attention was first directed to this form by Mr. F. E. Boynton, of the Biltmore Herbarium, for whom the species is named, by the exhibition of plants loaded with the characteristic and distinct fruit, and of branches displaying the glandular and brightly colored characters of the unfolding leaves and shoots. To this species I refer, in part, the material representing the southern distribution of *C. rotundifolia* of the Illustrated Flora[2], and the note under this name published by me in the BOTANICAL GAZETTE[3]. The type material is preserved in the Biltmore Herbarium.

CRATÆGUS TRIFLORA Chapm. Flora Southern United States, Suppl. II. 684. 1892 [Ed. 2].—A large shrub or small tree, 2–7^{m} tall, growing on limestone bluffs near Rome, Ga. (type locality), and in similar situations near Birmingham, Ala. Main

[2] Ill. Flora Northern U. S., etc., **2**: 243. 1897.

[3] BOT. GAZ. **25**: 446. 1898.

stem single, or branching near the base into several spreading shoots, armed with numerous branched spines: bark light gray, or with a decided tinge of brown, either close or slightly furrowed and broken into many small, plate-like scales: branches ascending, clothed with light gray, smooth bark and bearing a few simple or branched, straight or slightly curved, chestnut-brown to gray spines, 2.5–6^{em} long; they are intricately divided near the summit into many short, pilose or pubescent, brown or dark reddish-brown branchlets, forming an oblong or occasionally round or flat-topped head: buds globular, bright reddish-brown, the terminal one on strong shoots displaying several spreading scales: leaves, which are full grown at flowering time, thin at first, becoming subcoriaceous, dark green above, paler below, ovate, elliptical, or slightly obovate, acute at the apex, rounded or abruptly contracted at the base into a winged or margined petiole, 8^{mm}–3.5^{em} long: they vary in size from those on the fertile branches, which are 2–10^{em} long including the petiole, 1–5^{em} wide, to large, broad leaves on vigorous shoots, 13^{em} long, 8^{em} wide, the borders being sharply and irregularly serrate, or doubly serrate and incisely lobed and bearing, as does the petiole, a number of stalked, black-tipped glands near the base; the upper surface harshly and rather inconspicuously pubescent throughout the vegetating season, below more densely and permanently pubescent, especially along the 5–7 prominent veins: stipules lanceolate or oblong or on the stronger shoots foliaceous and lunate, densely glandular or glandular-serrate, caducous: flowers, which open about the first of May, disposed in few-, mostly 3-flowered, pilose corymbs: pedicels 1–3.5^{em} long, the lateral much longer than the intermediate one, bearing a densely or pectinately glandular, deciduous bractlet: calyx obconic, densely pilose, the segments persistent, pubescent, glandular-serrate, 7–9^{mm} long, 2–4^{mm} wide, acute: corolla 2–3^{em} wide, the divisions orbicular, 10–13^{mm} in diameter: stamens normally 20, 5–7^{mm} long: styles 3–5, surrounded at the base with pale hairs: fruit, which ripens about the middle of September, globose, 12–15^{mm} in diameter, bright

or deep red, pubescent, the cavity 5–6^{mm} broad, 3–5^{mm} deep: nutlets 3–5, hard and bony, 7–9^{mm} long, about 5^{mm} measured dorso-ventrally, a volume of 125^{cc} containing about 1633 clean and dry seeds.

The type material is preserved in the Chapman Herbarium at Biltmore.

Cratægus austromontana, n. sp.— A straggling shrub, 1–4^{m} in height, frequenting rocky woods and banks: main stems 1–3, arising from large coarse roots or horizontal rootstocks, or frequently a group or clump more or less united, occupying a surface of 5–10 square meters: bark close, or slightly broken into numerous small plates, gray, or with a decided tinge of brown: branches unarmed, or an occasional spine on a young plant or vigorous shoot, the bark smooth, gray or nearly brown: branchlets pilose-pubescent or tomentose, covered with dark chestnut or reddish-brown bark which is marked by round or elongated, pale lenticels, buds globular, bright reddish-brown: flowers large, borne in simple 2–5- (usually 3-) flowered cymes, opening in the vicinity of Valley Head, Ala. (type locality), the first part of May: pedicels stout, pilose or tomentose, 1–2.5^{cm} long, bearing a linear, glandular, deciduous bract near the summit: calyx broad, obconic, pubescent, the divisions lanceolate, 6–10^{mm} long, 1–3^{mm} wide, pectinately-glandular or glandular-serrate, pubescent: stamens 10, 4–7^{mm} long: pistils 3–5, surrounded at the base with pale hairs: fruit, which ripens and falls during the latter part of September, large, globose, 12–15^{mm} in diameter, bright red, pubescent, and frequently punctate, containing 3–5 hard, bony nutlets which are 8–10^{mm} long, 4–5^{mm} wide, measured from the back to the inner edge, bluntly angled on the back and with lateral faces narrow and nearly plane: cavity broad, 4–6^{mm} wide, surrounded by the persistent calyx lobes and remnants of the filaments: leaves orbicular, broadly oval or round-ovate, 3.5–12^{cm} long, including the pubescent or tomentose petiole, which, like the extreme base of the leaf, bears a number of stalked, black-tipped glands, 2.5–7.5^{cm} wide, or sometimes larger on strong shoots; they are harshly, though

rather inconspicuously, pubescent on both surfaces, the pubescence being more pronounced on the lower side and along the principal veins, which are disposed in about 5–7 pairs; acute at the apex, contracted at the rounded, truncate or sometimes subcordate base into a margined or winged petiole 1–4^{cm} long, the borders very sharply and irregularly serrate, or frequently doubly serrate or incisely lobed, the serratures tipped with minute dark colored glands.

Cratægus austromontana is distributed throughout the Sand mountain region of Alabama, and has also been collected at several stations in the Cumberland mountains and hill country of eastern and middle Tennessee. The new species is closely associated with *C. triflora* Chapm., but may be recognized by its smaller size, broader leaves, fewer stamens, and by the larger and coarser seeds. The type material is preserved in the Biltmore Herbarium.

Cratægus Harbisoni, n. sp.—A tree 5–8 meters in height, frequenting rocky slopes and ridges: leaves obovate, oval, or broadly ovate, 3–12^{cm} long including the petiole, 2–9^{cm} wide, acute at the apex, narrowed at the rounded or tapering base into margined or winged petioles; they are harshly and rather inconspicuously pubescent on the upper and more densely coated on the lower surface and along the 5–7 principal veins, subcoriaceous, dark green and lustrous above, pale below, the borders doubly and irregularly serrate to near the base, or frequently incisely lobed: petioles 6^{mm}–2^{cm} long, bearing, as does the extreme base of the blade, a number of stalked, black-tipped glands: stipules glandular-serrate or pectinately-glandular, deciduous, foliaceous on the stronger shoots, acute or lunate: flowers, which appear in early May in the vicinity of Nashville, Tennessee (type locality), produced in broad, pubescent, or pilose, divergently-branched corymbs, the lower branches from the axils of leaves: bracts subtending the branches of the corymbs large, 7–18^{mm} long, 2–4^{mm} broad, pectinately or glandular-serrate, caducous: pedicels pubescent or pilose, stout, 5^{mm}–3.5^{cm} long, bearing a pectinately-glandular, elongated,

deciduous bractlet: calyx obconic, pubescent, the lobes lanceolate, glandular-serrate, persistent: stamens normally 20, 4–6^{mm} long: pistils 3–5, surrounded at the base with pale hairs: fruit large, red, or orange-red, globose, 10–13^{mm} in diameter, pubescent or smooth, punctate, ripening in October: nutlets 3–5, 6–9^{mm} long, 4–5^{mm} from back to inner angle, either furrowed on the dorsal side or with a blunt ridge and two grooves, the lateral surfaces nearly plane, a volume of 125^{cc} containing about 1490 clean and dry seeds; cavity 4–6^{mm} wide: bark of the trunk, which is from 1–2^{dm} in diameter and 1–2 meters long, close or slightly fissured and scaly, ashy-gray or darker in color and frequently armed with simple or branched spines: branches clothed with smooth, gray or light brown bark, and bearing straight or curved chestnut-brown or gray spines 3–6^{cm} long, the growth of the season reddish-brown in color and marked by small, pale lenticels: buds nearly round, bright reddish-brown, the terminal one displaying several large, spreading, acute scales.

Cratægus Harbisoni was discovered by Mr. T. G. Harbison of the Biltmore Herbarium, for whom the species is named, on the limestone hills and ridges near Nashville, Tennessee, where numerous examples were observed at intervals during the past summer.

The new species probably belongs to a group of which *C. triflora* Chapm. and the *C. austromontana* previously proposed are types. From the former it may be separated by the compound, many-flowered corymbs, and from the latter by its greater size, numerous stamens, spiny branches, large flower-clusters, and the different habit of growth. The type material is preserved in the Biltmore Herbarium.

Cratægus silvicola, n. sp.—A tree, attaining in low moist woodlands a height of 6–10^{m}, or in upland forests a shrub with one or more stems, 1–5^{m} tall: trunk, which is sometimes 2^{dm} in diameter, covered with a close or slightly fissured and scaly, gray or reddish-brown bark, and armed with stout, branched spines: branches, which are spreading or ascending and form a

round or flat-topped head, armed with straight or curved, chestnut-brown or gray spines 2–6^{cm} long, and clothed with gray or light brown bark: branchlets chestnut- or reddish-brown, sprinkled with small pale lenticels: buds globular, bright reddish-brown: leaves ovate, round ovate or on vigorous shoots deltoid, acute at the apex, rounded and narrowed at the base, or occasionally truncate or subcordate, 3–10^{cm} long, including the petiole, 2–6^{cm} wide, the borders sharply and irregularly serrate, or doubly serrate and incisely 5–7-lobed, the serratures minutely glandular-apiculate; they are bright or yellowish-green and minutely roughened, or occasionally scabrous-pubescent on the upper surface, paler below and generally smooth, or with a few hairs along the larger veins, which are disposed in 3–5 pairs: petioles slender, 5^{mm}–3^{cm} long, glandular: pedicels strict, 7^{mm}–1.5^{cm} long: calyx obconic, the divisions short, entire or glandular-serrate, 3–4^{mm} long, acute: stamens 10: styles 3–5, surrounded at the base with pale hairs: fruit globose, 10–11^{mm} in diameter, red or greenish-yellow with ruddy cheek, ripening and falling the last of September in the vicinity of Gadsden, Alabama (type locality): nutlets 3–5, hard and bony, 5–6^{mm} long, 3–4^{mm} measured dorso-ventrally, the back ridged and grooved and the lateral faces nearly plane: flesh thin and firm.

Cratægus silvicola is abundantly represented in the "flatwoods" of northern Alabama and northwestern Georgia, and occasionally ascends into the poorer and drier woodlands of the surrounding country. The lower leaves and those from young plants are much rougher to the touch than foliage from the upper branches of the larger and older trees, but the fruit, which when ripe falls from the trees at the slightest interference, is constant in form and color. I presume the proposed species represents one of the several forms of the South Atlantic region heretofore referred to *C. coccinea*. L.[4] Taking the original description and a copy of a tracing of the type specimen of the scarlet thorn, *C. silvicola* may be distinguished by the rough leaves, which are less incised and broader and longer in outline,

[4] Sp. Pl. 476. 1753.

and by the short, strict, and stout pedicels. The type material is preserved in the Biltmore Herbarium.

Cratægus Mohri, n. sp.—A tree 6–10^{m} tall with a slender trunk 1–2^{dm} in diameter, unarmed, or sparsely furnished with long, simple or branched spines, and covered with thin, scaly, ashy-gray or reddish-brown bark; or in unfavorable situations a large, erect and branching shrub: branches ascending or nearly horizontal, spiny, forming an oblong or occasionally round compact head; the bark close and usually gray: branchlets and smaller branches zig-zag, armed with slightly curved or straight, chestnut-brown or gray spines 2–5^{cm} long; the growth of the season at first pubescent, clothed with light brown or gray, lustrous bark which is marked by small, pale lenticels: buds nearly round, or the lateral occasionally compressed, bright reddish-brown: leaves cuneate-obovate, or on vigorous shoots varying from oval to orbicular, 2–7^{cm} long including the petiole, 1.5–3^{cm} wide, or larger on the shoots, acute or rounded at the apex and contracted below into winged or margined petioles 7^{mm}–2^{cm} long, sharply and irregularly serrate to or below the middle, entire or nearly so at the base, and sometimes, especially on vigorous shoots, doubly serrate or incisely lobed; they are more or less pubescent along the veins when young, dark green and lustrous above, pale below, becoming thick and coriaceous with age: stipules linear, glandular, 5–10^{mm} long, caducous: flowers, which appear when the leaves are of full size, disposed in slender, elongated and often flexuous, many-flowered, bracteate corymbs, which are more or less pubescent or pilose at flowering time, and open in the vicinity of Rome, Georgia (type locality) about the first of May; they are 1.5–1.75^{cm} in diameter and borne on more or less pilose, slender, often flexuous pedicels 8^{mm}–2.5^{cm} long, which bear one or two minute, subulate, caducous bractlets: calyx narrow, obconic, glabrous or occasionally a little pilose; the segments linear-lanceolate, 2–5^{mm} long, entire or slightly glandular serrate, reflexed after anthesis; corolla white, the divisions round-ovate or nearly orbicular, 6–8^{mm} long, 5–7^{mm} wide with undulate or erose borders: stamens normally

20, 3–5^{mm} long: styles 3–5, surrounded at the base with pale hairs: fruit globose, 8–9^{mm} in diameter, dull, dark-red or greenish-red, or frequently covered with black spots and blotches, ripe about the first of October and hanging until early winter, the cavity 2–3^{mm} wide and deep, bordered by the remnants of the calyx lobes and stamens: nutlets 3–5, thick-walled, 5–7^{mm} long, about 3^{mm} wide measured dorso-ventrally, with a prominent ridge and two deep grooves on the back, the inner faces nearly plane.

Cratægus Mohri is distributed from Georgia westward through upper and central Alabama and Mississippi, and northward to middle Tennessee. It reaches its best development in the rich and moist soil of the "flat-woods" of central Alabama, though not infrequently it ascends into the poorer and drier soil of the hills and mountains. The species has been usually confounded with *Cratægus crus-galli* L.,[5] or more recently with *C. collina* Chapm.[6] From the former it may be recognized by the pilose corymbs, smaller and globular fruit, more numerous and smaller nutlets, habit of growth, and by the outline of the leaves; while from *C. collina* it may be separated by the later time of flowering, smaller fruit and nutlets, and by the luster of the leaves.

I take pleasure in associating with this beautiful and most distinct hawthorn, the name of Dr. Charles Mohr, of Mobile, Alabama.

The type material is preserved in the Biltmore Herbarium.

Biltmore Herbarium.

[5] Sp. Pl. 476. 1753.

[6] Flora S. U. S., suppl. II. 684. 1892. [Ed. 2.]

BRIEFER ARTICLES.

SOME PECULIARITIES IN PUCCINIA TELEUTOSPORES.[1]

(WITH SIX FIGURES)

THE distinguishing characteristics of many Puccinia teleutospores are very slight, while on the other hand such species as *P. podophylli*, *coronata*, *pruni*, etc., are, in typical specimens, at once set aside from all others by the markings of their epispores. In many species, variations in the number and position of the septa are characteristic. Generally, however, the shape and size of the spores are fairly constant, and this is particularly true of *P. graminis* Pers. and allied gramineous rusts. Occasionally one-celled spores are found, due perhaps, as Professor Burrill[2] suggests, to insufficient nutrition. Eriksson and Henning[3] call attention to the so-called mesospores and other peculiarities found among spores from closed sori of *P. graminis*, attributing them to the pressure of the epidermis, and Bolley[4] in regard to the anomalous shapes found among spores says "certain it is that pressure within the crowded sorus is capable of producing an almost unlimited number of irregularities in the spore forms." J. A. Warren[5] has written regarding some very striking variations in the spores of *P. Windsoriæ* Schw., while Dietel,[6] writing on peculiarities in Puccinia spores, refers to the finding of a well-developed four-celled spore of *P. graminis*, and from time to time the odd shapes of rust spores have been noted by various writers.

Puccinia heterospora B. & C. is a species showing many interesting variations, giving as they do an indication of the close relationship of

[1] Contribution from Botanical Dept. Iowa State College of Agriculture and Mechanic Arts, no. 16.

[2] Parasitic fungi of Illinois **1**: 171. 1885.

[3] Die Getreideroste 129. *pl. 4*.

[4] Sub-epidermal rusts. BOT. GAZ. **14**: 139–144. *pl. 15*. Je. 1889.

[5] Notes on the variations of *Puccinia Windsoriae*, Am. Nat. **32**: 779–781. *pl. 1*. 1898.

[6] Beiträge zur Morphologie und Biologie der Uredineen. Bot. Centralblatt **32**: 86–88. 1887.

the Uromyces and Puccinia genera of the Uredineæ; in fact, this species must be regarded as one of the connecting links between the two. The spores are of two kinds, one and two-celled, the one-celled being globose to subglobose, and measuring $19 \times 28\mu$.

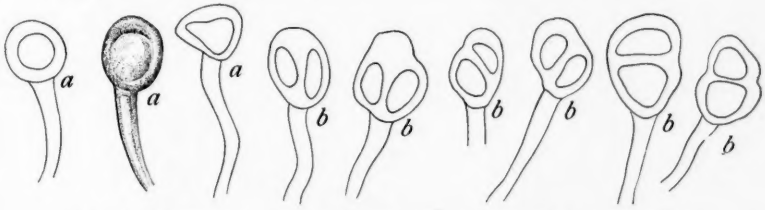


FIG. 1.—Teleutospores of *Puccinia heterospora*. *a*, one-celled; *b*, two-celled.

The two-celled spores are of three kinds: some have the septum transverse, in some it is oblique, while in others it coincides with the axis of the spore. The measurements do not differ materially from those given for the one-celled spores. The one-celled forms are much more numerous and the epispores of all are thick and smooth.

In 1884, Dr. Trelease[7] described a species occurring on *Bromus ciliatus* and called it *P. tomipara*. He says, "this species is remarkable

FIG. 2.—Teleutospores of *Puccinia tomipara*. *a*, one-celled; *b*, two-celled; *c*, three-celled; *d*, four-celled.

from the fact that the spores are commonly three or four-celled with the uppermost septum oblique or not infrequently parallel to the axis of the spore, which is thus made to consist of more than one row of cells." To this comment on the very variable spores of this species nothing can be added.

Puccinia irregularis E. & T. is another species showing variable teleutospores, one, two, and three-celled spores being found. The

[7] Preliminary list of parasitic fungi of Wisconsin 22–23. N. 1884.

septa are always transverse. In addition to the variation in the number of cells, the spores are peculiar because of the position of strongly developed papillae. Usually a single papilla is found at the apex of the spore, but often the spores are truncate, when two papillae appear,

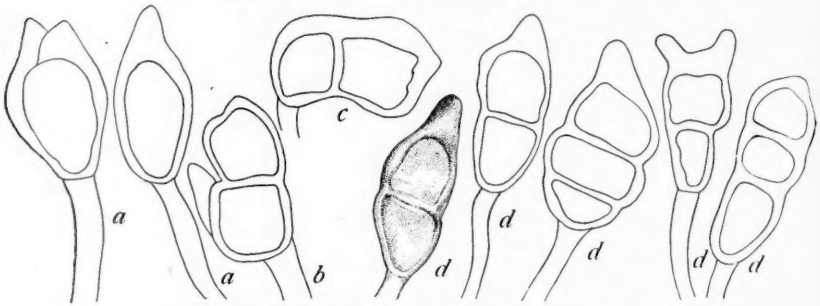


FIG. 3.—Teleutospores of *Puccinia irregularis*. *a*, one-celled; *b*, with papilla below septum; *c*, with side thickening; *d*, two- and three-celled.

one on each side. In some the papilla is found just below the septum. One spore was observed having the whole of one side thickened instead of the apex. The spores measure 50–75 × 19–28μ, the one-celled spores being somewhat smaller.

An examination of the material in the herbaria of the Missouri Botanical Garden and the Iowa State College leads to the belief that this is undoubtedly the species referred to *P. Solidaginis* Pk. by Dr. Trelease, no. 169, *Preliminary list of parasitic fungi of Wisconsin*.

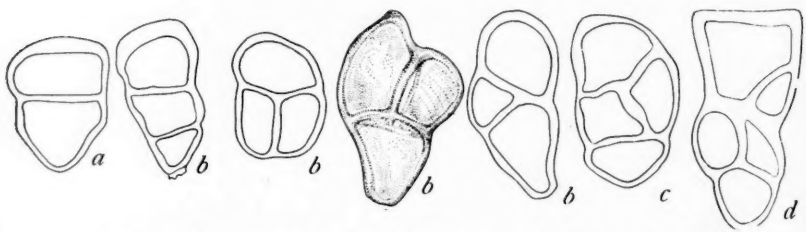


FIG. 4.—Teleutospores of *Puccinia Montanensis*. *a*, normal; *b*, three-celled; *c*, four-celled; *d*, five-celled.

A specimen of Puccinia occurring on *Elymus robustus* was collected at Ames, Iowa, by G. W. Carver, October 14, 1895. The greater number of the spores were quite normal in shape and just what might

be expected in a Puccinia, but among them were found a few spores of more than two cells. The multicellular spores were in some cases not unlike those of *P. triarticulata* B. & C., but owing to their scarcity and the fact that the two-celled spores agree in size and shape with those

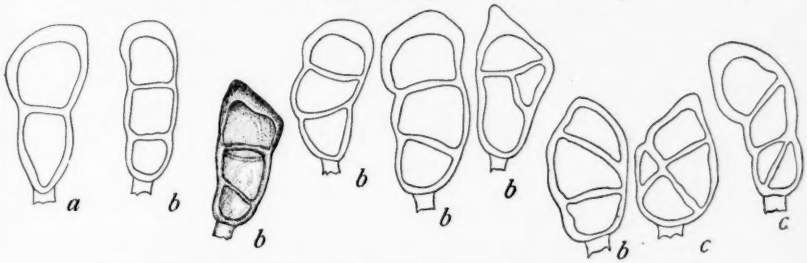


FIG. 5.—Teleutospores of *Puccinia Rubigo-vera*. *a*, normal; *b*, three-celled; c, four-celled.

of *P. Montanensis* Ell. it is best to regard it as that species. The position of the septa in some of the spores would be very hard to describe. Some spores were quite regularly three and four-celled, while in others oblique, transverse, and perpendicular septa were present, all in one spore. The three-celled forms were of two kinds, regular ones, and those in which two cells were found at the apex with one at the base, but occasionally this was just reversed. The measurements varied from $33\times25\mu$ to $55\times33\mu$.

A specimen of *Puccinia Rubigo-vera* (DC.) Wint. on *Agropyron tenerum*, collected at Ames in 1896, showed a considerable number of spores having three and four cells. The normal two-celled spores were greatly in excess of the others, being found in the proportion of about fifty to one. The three-celled forms were usually somewhat irregular, though occasionally one was found in which the septa crossed the spore at the right angles to the lateral walls. The four-celled forms were fewer in number than the three-celled, only a half dozen being found in three mounts. The septa were so placed as to divide the spore in different planes. The measurements of all were confined within the usual limits for this species, $13–20\times28–56\mu$.

On November 24, 1898, the writer picked up a piece of rust-affected oat straw (*Avena sativa* L.) on the road in front of the dairy building at the Iowa State College. The rust sori presented all the features of the sori of *P. graminis* Pers., appearing on the sheath as black linear or oval confluent patches.

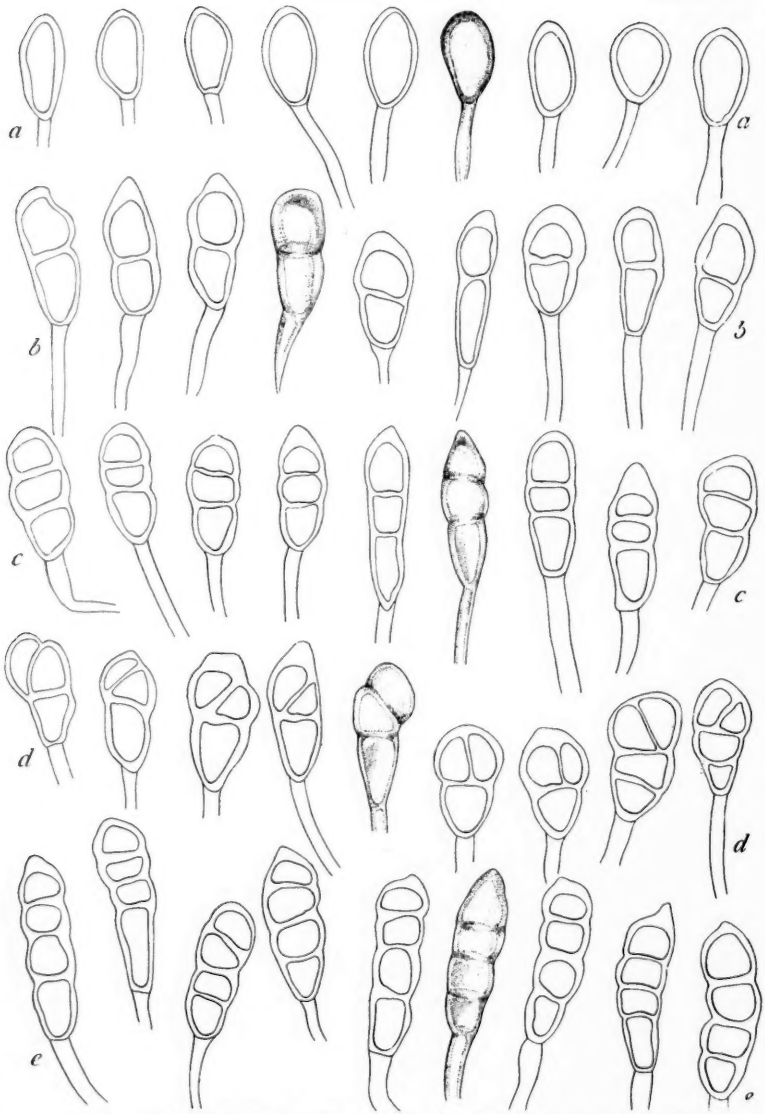


FIG. 6.—Teleutospores of *Puccinia graminis*. *a–a*, one-celled; *b–b*, normal; *c–c*, three-celled, septum horizontal; *d–d*, three- and four-celled, septum oblique; *e–e*, four-celled, septum horizontal.

A microscopical examination made sometime afterward revealed some noteworthy peculiarities in the shape, size, and number of cells in the teleutospores. The usual two-celled spores were present but accompanied by others having one, three, and four cells.

The different forms were about equal in number but differed considerably in size, the four-celled variety being the largest, as one would naturally expect. Of each form ten measurements were made, giving the following extremes: one-celled, 27–36×15–20μ; two-celled, 30–45×15–21μ; three-celled, 45–54×15–21μ; four-celled, 52–66×15–20μ.

The one-celled spores might easily have passed for the teleutospores of some Uromyces such as *U. graminicola* Burrill. The two-celled ones were quite normal in size and shape, except that in some the pedicels were much stouter than are usually found in *P. graminis*, more closely resembling the pedicels of *P. emaculata* Schw. The three and four-celled forms were of three kinds, some having the upper septum horizontal, some oblique, and others vertical, as though the upper cell had been formed as a sort of afterthought, by the division of the second or third cell as the case might be.

In these the evolutionary development of several genera of Uredinae could be plainly traced, passing from the lower Uromyces through Puccinia and Triphragmium to Phragmidium. The spores, aside from the number of cells, were not likely to be mistaken for those of Triphragmium or Phragmidium, as they were quite different in general appearance. These genera have undoubtedly a common origin, and must be looked upon as being more highly developed, more specialized, in direct relation to the number of cells in the spores, as it is quite apparent that a larger number of sporidia can be produced with less effort in those having the larger number of divisions in the spores.— H. HAROLD HUME, *Iowa State College, Ames.*

WHAT IS PRUNUS INSITITIA?

IN the June number of the BOTANICAL GAZETTE there appeared an article under the heading given above and written by Professor F. A. Waugh. The conclusion to which the author arrives, in his own words, is "that there is no such species as *Prunus insititia*."

To me this seems rather strange. I happen to have been born in the land of Linnæus and received a large portion of my botanical

education at the Royal Gymnasium at Skara, Sweden. As a boy, I used to pick and eat the fruit of what there is known as *Prunus insititia*, and as a young botanist I made herbarium specimens thereof. I know that the tree which goes under that name is more distinct from *P. domestica*, as well as from *P. spinosa*, than *P. hortulana*, or *P. nigra*, or even *P. angustifolia* is from *P. Americana*. I know that there are at least three species of plums in Sweden, for I have seen them myself.

The latest catalogue of the plants of Scandinavia, published in 1897, also gives the following plums: "*Prunus spinosa* L., *P. spinosa coætanea* W. &. Gr., *P. insititia* L., *P. insititia rustica* Hn., and *P. domestica* L." Of these the first three are recognized as being natives of Sweden, while *P. domestica* and *P. insititia rustica* are regarded as only escaped from cultivation. So far as I know, *P. insititia* L. has always been regarded as a good species in Sweden; but let us see how botanists of other countries have treated it.

As Linnæus in the original description stated that *P. insititia* is a native of England and Germany, it will suffice to see how the botanists of those countries have treated the species. In almost every German flora *P. insititia* is regarded as a good species. Koch, the acknowledged authority in Germany, recognized it, and in Thomé's elaborate work there is an excellent description.

It is true that Bentham put *P. domestica*, *P. insititia*, and *P. spinosa* into *P. communis* Huds.; but Hooker, who has always been known for his conservatism, recognized all three as distinct species, not to mention other less important English botanists. It is figured in Sowerby's English Botany **12**: 841.

With these facts in view, it is surprising that one who has not studied the native plums of Europe in the field, with the few specimens found in the American herbaria, undertakes to settle the existence or non-existence of *P. insititia*, and can state positively "that there is no such species as *P. insititia*."

If Professor Waugh had said that *P. insititia* is the same as *P. domestica Damascena*, or that *P. insititia* is not found in America, I should have been the last to criticise. I have not the means to disprove the former, and I am more than willing to accept the latter. *P. domestica Damascena* L. was based upon "*Pruna majora dulcia et parva atrocaerulea, Bauh. pin. 443*, n. 23," and *P. insititia* L. on "*Pruna sylvestria praecocia, Bauh. pin. 444*." Apparently, therefore, they seem to be two different things. For that matter they might well belong to

the same species. Koch states in the older edition of his *Flora* that Linnæus included several forms in *P. domestica*, which rightfully belonged to *P. insititia*. Even this question has to be settled in Europe.

As to the non-existence of *P. insititia* in America, I agree fully with Professor Waugh, for the following reasons: If Dr. Gray had had what is known as *P. insititia* in Sweden, I doubt that he would have made it a variety of *P. spinosa*. Dr. Gray's statement that it is "adventitious in hedgerows" made me very suspicious when I saw it in his manual a year or two ago; for *P. insititia*, so far as I know, is never used for hedges. I think that *P. insititia* should be erased from the list of American plants.—P. A. RYDBERG, *New York Botanical Garden*.

NOTES ON THOREA.

(WITH PLATE XXVI)

ON October 1, 1898, Mr. A. A. Hunter, collector for the botanical department of the University of Nebraska, found specimens of *Thorea ramosissima* Bory in Rock creek, a small stream near Lincoln, Neb.[1] The plants were floating from a gravelly bottom in swift running water at a depth of half a meter and were surrounded by a mass of other algæ, principally Vaucheria. Subsequent search for Thorea in this locality has thus far proved unavailing.

So far as we know, Thorea has been found to a certainty in but three other localities in North America. E. Hall collected a specimen of *Thorea ramosissima* Bory in the Sangamon river, Illinois, in 1866, and this, with specimens of other fresh water algæ, was afterwards sent to the Botanical Museum of Berlin, where it is still preserved.[2] Francis Wolle found a mere fragment of Thorea in a lake at Winter Park, Florida, date not given.[3] Professor De Alton Saunders,[4] in December 1898, found Thorea in abundance in running water from springs in Texas, the stations being San Marcos (Hayes county), New Braunfels (Comal county), and San Antonio (Bexar county).

[1] See notice in BOT. GAZ. **27**: 71. 1899.

[2] MAGNUS: *Thorea ramosissima* Bory bei Belgrad in Serbien und denen weitere Verbreitung. Hedwigia **38**: 114. 1899.

[3] WOLLE: Fresh water algæ of the United States, 58. 1887.

[4] Communicated in a letter, accompanied by specimens in formalin.

Thorea is widely distributed over the world, having been reported from France, Germany, England, Denmark, Austria, Venezuela, Ecuador, Java, and the Marianne islands. In Ecuador it is said to be especially abundant.

Our description of the Nebraska plant does not differ essentially from that of Schmidle in his excellent monograph of *Thorea ramosissima* Bory.[5] In our plant the body consists of long cylindrical branches, originating near the base, and these again have occasional branches. The color is an olive green, rather than the black or brown color mentioned by Schmidle. When dried, the plant retains its olive green color, becoming somewhat brownish. The whole plant is about 5^{dm} long, and 2 to 3^{em} wide, when floating in the water. Each branch consists of two distinct portions, viz., an outer covering of several-celled hairs or ramelli, and a denser axial portion of interlacing cellular filaments, which are held more firmly together by a mucilaginous matrix which sheaths every fiber and extends outwards as far as the first two or three basal cells of the hairs. The surrounding zone of hairs has a width of from 400 to 600μ, being of nearly the same diameter upon all portions of the plant body, except at the base. The axial portion has a varying diameter, ranging from 700μ at the base to less than 100μ at the growing point of the branch.

The hairs grow at right angles to the axis and constitute two quite distinct belts; an outer belt of quite evenly distributed long hairs, having an average length of 500μ; and an inner belt of clustered, short hairs of an average length of 70 to 90μ. The long and short hairs are intermingled, and both kinds spring from the same basal cell. The short hairs are protected by gelatinous sheaths, which are extensions of the central gelatinous matrix. The cells of the long hairs are rectangular in shape, and quite uniform in diameter. The short hairs have shorter cells, which are also nearly uniform in diameter, yet in some cases they taper slightly towards the apex. In the older portions of the branches the short hairs are more numerous, while in the younger region the long hairs predominate. As the plant matures, the apical cell of the short hairs often develops into an asexual spore (aplanospore). Among the short hairs, and often from the same basal cells, there may arise narrow hairs which develop a small cluster of similar asexual spores, rarely over five in number.

[5] SCHMIDLE: Untersuchungen über *Thorea ramosissima* Bory. Hedwigia 35:1–33. 1896.

In both cases the spores when young are spherical, and when mature the former are oval, the latter pyriform.

The axis consists of three structural parts: (1) a more or less distinct outer portion, of irregular basal cells from which the hairs originate; (2) a belt of interlacing cellular fibers most of which run longitudinally in the axis; these fibers are connected either to certain hair clusters by basal cells, or in some cases to a single long hair; there are frequent oblique or transverse fibers among the longitudinal; (3) the innermost portion of the axis consisting of an interlacing mass of cellular fibers running in all directions; these are connections or continuations of the outer longitudinal and transverse fibers.

Each hair cell contains greenish, disk-shaped chromatophores, and a distinct nucleus. There is also a distinct protoplasmic connection between the cells through the center of each cell partition. The fibers near the outer edge of the axis, especially those directly connected to the hairs by basal cells, contain chlorophyll bodies more or less irregular in shape, and show in many cases intercellular protoplasmic connections similar to those in the hairs. The intercellular walls of the internal fibers are often oblique, but are always transverse in the enlarged portions. Towards the center of the axis chlorophyll bodies become rarer, and in some fibers entirely disappear.

We found, also, in the outer portion of the axis certain longitudinal fibers, which show no chlorophyll bodies, and whose protoplasmic contents seem to be homogenous. Cell partitions in these are either lacking or at considerable distances apart. These fibers branch occasionally, and are connected in a few cases to basal cells of hair clusters. Others are united to the oblique or transverse fibers. In sections which had been treated on the slide with acid alcohol to remove the gelatinous sheaths, and first stained for two or three hours with acid orseillin, then with methyl green or echtgrün for one minute, these fibers were differentiated from the others, the cell contents staining red in contrast to the thick unstained or slightly green membrane. We are unable to assign any particular function to these fibers further than that they are a portion of the assimilative axial region of the plant. The hairs are both vegetative and reproductive in function.

According to Schmidle, Thorea has three distinct life forms or stages of growth. The first, or prothallium stage, consists of more or less branched cellular fibers which develop directly from the spores. We found plants in this stage, but found neither spores nor tetraspores

developing from them. Schmidle found what he thought might be tetraspores, but questions their existence. The second, or Chantransia stage, develops directly from the former. The plants assume a Chantransia-like form, growing up in little dark green or brown tufts on the surface of stones, etc., at the bottom of running streams. In this stage Thorea bears asexual spores in abundance. The third and most highly developed form of Thorea is the branching plant body described above. It develops from a union and growth of a number of Chantransia-like plants into a branching thallus of greater size, yet possessing all the forms of structure found in the preceding stages, with the addition of carpogones.

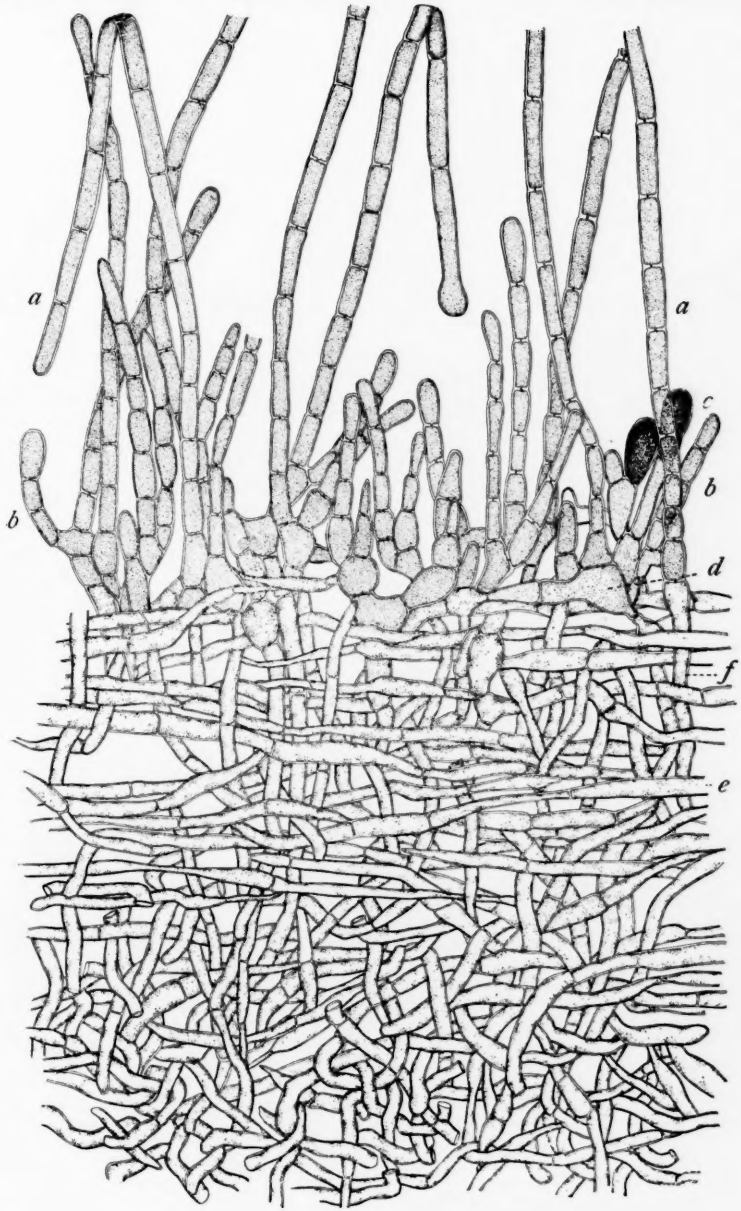
The position of Thorea was long in doubt. Moebius in 1891–2 placed it among the Florideæ.[6] Schmitz in 1892 placed it among the Phaeophyceæ,[7] but changed his mind in 1894[8] and left it between this group and the Florideæ, giving preference to the latter. Schmidle, who has devoted more time to the study of Thorea than any other botanist, is certain that it properly belongs to the Florideæ for the following reasons: (1) in containing phycoerythrin, like the red seaweeds; (2) in having cystocarps resembling those of Batrachospermum; (3) in that the hair cells contain intercellular protoplasmic connections typical of many of the lower Florideæ; (4) in developing from Chantransia-like forms in much the same manner as Batrachospermum.

The Nebraska specimens of Thorea agree in points of general structure with the published descriptions of *Thorea ramosissima* Bory, with a few exceptions. The plants have a decided olive-green color which persists in the herbarium specimens, rather than the purple tinge of the dried specimens from Worms and Paris. Our Thorea branches very sparingly, the longer branches often attaining a length of 3^{dm} without side branches. On the contrary, the specimens from Worms and Paris are much branched, the diameter of the zone of hairs also being two or three times greater than that of the central portion while in ours the zone of hairs has nearly the same diameter as the central portion. There is a marked difference in the hairs as found in our material and that obtained by Professor Saunders in Texas. In the former both the long and short hairs are of nearly equal diameter

[6] MOEBIUS: Ber. d. deut. bot. Gesell. **10**: 333–344. 1891; **11**: 266–270. 1892.

[7] SCHMITZ: Ber. d. deut. bot. Gesell. **11**: 115–141. 1892.

[8] SCHMITZ: Nuova Notarisia **5**: 705–720. 1894.



HEDGCOCK and HUNTER on THOREA

throughout their length, while in the latter a great many of the longer hairs as well as many of the shorter ones taper almost to a point.

The description and measurements of structural parts are as follows:

ZONE OF HAIRS (300–500μ in diameter).

Hairs: (*a*, *pl. XXVI*) long hairs consisting of 18–20 (more or less) cells outside the gelatinous sheath, counting from the basal cells; diameter of outer cells 5–8μ, of inner 5–8μ; length of middle and outer (apical) cells 18–40μ, of basal 13–20μ; shape of basal cells elliptical to oval, of outer mostly rectangular, of apical usually rounded at tip.

(*b*) Short hairs consisting of 1–6 cells outside the basal cells; diameter of basal cells 6–8μ, of apical 4–6μ (rarely wider than the basal); length of cells 13–16μ; shape of basal cells round to elliptical or oval; of the others rounded to rectangular (apical often pyriform).

Spores (*c*), single or in clusters, 10–15μ in diameter, 15–26μ long, spherical when young, pyriform when mature.

INTERNAL FILAMENTS.

Basal cells (*d*) 8–18μ in diameter (broader in a few cases), 10–40μ in length (rarely larger), oblong to ovoid, often very irregular.

Cells of longitudinal fibers (*e*) 3–15μ in diameter, very variable and often indefinite in length, irregularly cylindrical and often tapering.

Cells of transverse fibers (*f*) 4–12μ in diameter, much extended and variable in length, irregularly cylindrical.

GEORGE G. HEDGCOCK and ABEL A. HUNTER, *University of Nebraska.*

EXPLANATION OF PLATE XXVI.—The plate represents a longitudinal radial section of a branch a short distance from the base, reaching from the outer edge of hairs to the middle of the axis. ×450. *a*, long hair; *b*, short hair; *c*, spore formed from a single end cell; *d*, basal cell; *e*, longitudinal fiber of central portion; *f*, transverse fiber of central portion.

NOTE ON CORN SMUT.

A FEW years ago the per cent. of smut on corn in the vicinity of Manhattan was investigated with considerable care.[1]

The tables then presented, which included three years' observations, show that the average of all counts made in August gave 6.2 per cent. of smutted stalks. This year the amount of smut was greater, one field giving 90 smutted stalks in 840, or 10.7 per cent. Another,

[1] A. S. HITCHCOCK and J. B. S. NORTON, Bulletin 62, Kansas Experiment Station, December 1896.

250 smutted stalks in 1250, or 20 per cent. These observations were made in order to compare the results with those obtained from the third field, where 140 stalks showed 38 to be smutted, or 27 per cent. This field was an experimental plat in which a number of crossed varieties were being self-pollinated. The tassels to be used for this purpose were enclosed in sacks, but the remainder were pulled out when young. At the time the pollinating was begun, several ears were beginning to silk. These were cut off with a corn knife. In some cases the entire ear was cut off; in others it was cut above the base. After a period the ears were allowed to grow as they appeared. In this last plat 117 stalks had ears upon them of which 10 had been cut. Of the 10 cut ears 9 were smutted, or 90 per cent.; of the 107 uncut ears 5 were smutted, or 4.7 per cent. The cut ears were growing at the time of mutilation. These observations serve to show that corn smut is greatly increased by mutilation which exposes the growing issue.— A. S. HITCHCOCK, *Manhattan, Kan.*

A BOTANICAL ART GALLERY

DURING the past season the University of Minnesota has taken steps to found a photographic exhibit of the vegetation of the state, and several hundred dollars have been expended for experimental work. The results are so far gratifying that the writer feels justified in giving the outlines of the plan for the benefit of other institutions that may care to develop similar exhibits.

Considerable time was spent during the summer in securing negatives of vegetation. A photographer has been continuously employed, and about 300 8 × 10 negatives have been obtained. For the present the efforts have been limited to (*a*) plant portraits in their habitats and (*b*) ecologic groups. Many of these have been enlarged and framed. A commodious and well-lighted room has been chosen for the hanging, and at present twenty enlargements, 30 × 40, and several of smaller size, have been hung as the nucleus of the gallery. The pictures are numbered and framed in the ordinary manner, and promise to have much educational value, not only to undergraduates, but to the public generally.

I find that a picture 30 × 40 can be produced, properly framed and hung, at a minimum expense of about $17. Higher prices are, however, demanded for the best work in framing. It is important to

command the services of very expert photographers and skillful enlargers to obtain proper results. A good negative can be produced at an average price of $2.50. Enlargement costs about $6, and the frame cannot be secured for less than $8.50. This price is trifling when the beauty and value of the whole exhibit is taken into account.

Among the subjects of study that I have used might be named portraits of Verbascum, Euphorbia, Helianthus, Solidago, Laciniaria, Castalia, Pteris, Quercus, Cuscuta, Pyrola, and groups of shore-lines, shade-plants, mat-plants, wand-plants, forest-floor coverings, swamp vegetation, etc. Such an exhibit when fairly extended would give a very adequate and pleasing idea of the vegetation in the region that has been selected for analysis.—CONWAY MACMILLAN, *The University of Minnesota.*

A NEW LILIUM.

Lilium Masseyi, n. sp.—Bulb 12^{mm} in diameter or less, composed of fleshy scales: stem 1.5 to 3^{dm} high, with two distant scales below: leaves linear, acute at both ends or the lower obtuse, 12 to 25^{mm} long, 2 to 4^{mm} wide, in whorls of 3 to 8, the central ones generally alternate, glaucous, the margins revolute, prominently three-veined: flowers 1 to 3, erect, 2.5 to 5^{cm} high; perianth reddish-orange, its segments spatulate, obtuse, slightly pubescent, the blade 6 to 12^{mm} wide, gradually narrowed into the claw, purple spotted below: capsule obovoid, 12 to 25^{mm} high.

High mountain meadows of North Carolina, July–August. Named in honor of Professor W. F. Massey, Horticulturist N. C. Agr. Exp. Station.—C. W. HYAMS, *Agric. Exper. Station, West Raleigh, N. C.*

CURRENT LITERATURE.

BOOK REVIEWS.

Flower ecology.

AS PREVIOUSLY stated in the pages of this journal (**26**: 358), the first volume of Knuth's *Handbuch der Blütenbiologie*"[1] gives a general introduction to the subject of the pollination of flowers, with the bibliography.

The second volume gives an account of the investigations which have been made upon the European and Arctic floras. The work being professedly based upon Hermann Müller's "Befruchtung der Blumen durch Insekten," even more closely resembles the English translation by Thompson, "The Fertilization of Flowers." The resemblance here extends to the introduction of the general results of other authors and in the arrangement of the families, part 1 including the Ranunculaceæ to Compositae, and part 2, Lobeliaceae to Gnetaceæ. As an example of the treatment of the particular cases we may take that of *Malva silvestris*. There is a citation of authors, an account of the mode of pollination, accompanied by a reproduction of Müller's figures, and a combined list of visitors observed by Müller and the author. Then follows the visitors observed by Alfken, Schletterer, Schenck, Loew, Scott-Elliot, and Smith. The lists are often quite fragmentary, observed in different places, and under varying conditions, so that they will hardly form a homogeneous combination, but it is a good thing to have them collected together. The fact that the most scattered and inaccessible writings are usually the most worthless does not keep anyone from rejoicing that he does not have to waste his time hunting for them. Knuth draws upon the writings of pure entomologists. Their writings are very important for the insects they especially collect, but, as a rule, they do not notice all of the visitors. Their lists are far better than those made out by persons who make you wonder if they can tell a hive-bee or bumblebee from an Eristalis.

The first part contains 697 pages, 210 figures, and as a frontispiece a portrait of Herman Müller. For a frontispiece the second part contains a portrait of Darwin, surrounded by Severin Axell, Federico Delpino, F. Hildebrand, and Fritz Müller. This part contains another 210 figures. The

[1] KNUTH, PAUL: Handbuch der Blütenbiologie unter Zugrundelegung von Hermann Müller's Werk "Die Befruchtung der Blumen durch Insekten." Band II: Die bisher in Europa und im arktischen Gebiet gemachten blüthenbiologischen Beobachtungen. Teil 2: Lobeliaceæ bis Gnetaceæ. 8vo. pp. iv + 705. *pl. 1. figs. 210.* Leipzig: Wilhelm Engelmann, 1899. *M* 18. geb. *M* 21.

volume closes with a list of the flower-visiting insects, each species being followed by a list of the plants on whose flowers it has been taken.

Facts appear here which are quite interesting in connection with statements made on page 114 of the first volume, as well as in connection with some recent writings of mine on oligotropic bees (BOT. GAZ. **28**: 32). *Andrena florea*, mentioned on the page cited as an exclusive visitor of *Bryonia dioica*, appears in **2**: 606 as a visitor of *Bryonia alba*, also, as well as *Sisymbrium officinale*, *Stellaria media*, *Rubus fruticosus*, *Cirsium arvense*, and *Carduus nutans*. *Andrena cettii* (= *A. marginata* F.), mentioned in **1**: 114 as an exclusive visitor of *Scabiosa* (Knautia) *arvensis*, in **2**: 607 is shown to visit *S. columbaria* and *S. suaveolens*, also, as well as *Succisa pratensis*, *Onopordon acanthium*, *Leontodon autumnalis*, *Hieracium pilosella*, *Jasione montana*. *Andrena nasuta* visits *Melilotus alba* also, and *Bombus gerstaeckeri* visits three species of *Aconitum* and *Gentiana asclepiadea*. So all of the exclusive cases are shown to be merely erroneous inferences from improbable data. These lists were evidently made later, and so are not connected with the first statements.

In this work the classification, although systematic within each volume, is geographical. The second volume contains observations made in Europe, excluding all others. If a native European plant has been introduced, for example, to America, any observations made upon the plant in America should be included with the observations made in Europe. This permits a convenient comparison of its normal relations at home with its acquired relations abroad. The latter are clearly subordinate and cannot take the place of the other.

If we enter upon close criticism of the present status of flower ecology, it must be said that it is a heterogeneous mixture of data derived from native plants occupying more or less normal positions in the original flora and exposed to a more or less normal insect fauna, as well as data derived from introduced and cultivated plants which seem erroneously to be expected to reveal their ecological relations without regard to their surroundings. It seems to me that introduced plants should be treated together in a supplementary part, while garden flowers should be again separated as surrounded by conditions clearly abnormal. The objection is to the mixture, not to any kind of data.

By the mystagogues, who amuse themselves by changing names, the nomenclature is quite likely to be regarded as not sufficiently unintelligible to the unskillful. But those who have to consult the literature have to use the nomenclature which is connected with it, whether they like it or not.

This work is by far the most important source of information on the facts and literature of flower ecology, and it should be in the hands of all those who are interested in the subject. I have done enough work with bibliography

to observe that too large a part of it does not show anything except that the writers were ignorant of the literature. Even their interest is shown to be fraudulent. They expect us to take an interest in their writings, when they do not care enough for the subject to read what has been written by others.

CHARLES ROBERTSON.

Propagation of mosses.

DR. CARL CORRENS has been at work for five years upon the vegetative reproduction of the true mosses. In that time he has published several preliminary papers on his researches,[2] and an important collateral paper "Ueber Scheitelwachsthum, Blattstellung, und Astanlagen des Laubmoosstämmchen" in the *Festschrift für Schwendener* (1899). These investigations are now brought together *in extenso* to form a bulky volume of almost 500 pages.[3]

The gametophyte of mosses propagates itself by many methods and by brood-bodies which arise from protonema, or rhizoid, or stem, or leaf. The sporophyte produces normally no propagative organs except the spores. The homology of the brood-bodies of Georgia (with which the researches of Correns began in 1894), Œdipodium, Drepanophyllum, and a few others (all of possible paraphysine nature) remain undetermined. The term brood-organs is restricted to those structures of which propagation is the chief or the coördinate function. The term cuttings is applied to those parts artificially separated by which propagation is possible. The brood-organs of one hundred and twenty-five species are monographically described. Forty species which can be reproduced from cuttings are also elaborately treated.

The terms applied to the brood-bodies have such resemblance in form and sound in German that they must prove objectionable, particularly in speaking. *Bruchstämmchen* or *Bruchäste* are stems or branches which are brittle throughout and may break off anywhere, or even break up into pieces, each capable of growth. *Brutäste* are brittle at base only where a separation layer is formed. *Bruchknospen* are branches brittle only beneath the apex, while *Brutknospen* are short *Brutäste*. In such a case perhaps it is unimportant whether one perceives the distinction between *Bruch* and *Brut!* In the same way we have *Bruchblätter* and *Brutblätter*. *Bulbillen* are defined as *Brutknospen* with reduced leaves, but the organs described as bulbils in *Leptobryum pyriforme* bear not the slightest trace of leaf rudiments; indeed they are elsewhere called "root tubercles."

In the general part (pp. 325–460) Dr. Correns discusses the morphology and phylogeny of the brood-bodies arising on stem, leaves, and protonema.

[2] Berichte d. deutsch. bot. Gesells. 13: 420. 1895; 14: 94. 1896; 15: 373. 1897; 16: 22. 1898.

[3] CORRENS, CARL: Untersuchungen über die Vermehrung der Laubmoose durch Brutorgane und Stecklinge. 8vo. pp. xxiv+472. *figs. 185*. Jena: Gustav Fischer. 1899. *M* 15.

He rejects Schimper's view that the cluster of gemmæ in Georgia and Œdipodium is homologous with a male "flower," the gemmæ being sterilized antheridia; and also dismisses as improbable Brefeld's suggestion that they are sterile sporangia, like chlamydospores.

The structure and development of the brood-bodies, their separation, distribution, mode and conditions of germination, and the conditions for their formation are described. Finally the author furnishes a key to the various kinds of brood organs and the species in which they occur.

A list of the literature, which consists mainly of the systematic works referred to, the special literature being very scanty, and an inadequate index complete the work.

The interest and value of the book lie in the exhaustive treatment of a subject, presumably narrow, which has shown itself broad when thoroughly studied. It would be interesting to have a similar study of the vegetative reproduction among the Hepaticæ, and we trust Dr. Correns will include in this thorough investigation both classes of the Bryophyta.—C. R. B.

NOTES FOR STUDENTS

VÖCHTING, the author of the well-known work on Transplantation and of various papers having to do with the correlations of organs and tissues, has published the results of some extended investigations on tuberous plants.[4] It is essentially, as he terms it, a study of the vicarious organs of these plants, and is a continuation and extension of a line of work begun long ago. The power of one organ to perform the function of another in case of need has long been known, and many instances of this phenomenon have been summarized by Hertwig among animals and by Goebel and Vöchting among plants. As long ago as 1803 Knight grafted the stem of a grape vine upon a petiole, and the latter organ developed woody tissue as a result. The author himself showed in previous studies that a potato tuber may be inserted into the stem and caused to develop mechanical and conductive tissues, and that the suppression of the tubers of the artichoke is followed by a swelling of other organs to take their place. In the above cases the replacing organ is essentially the same in kind as that replaced, but Vöchting now shows that almost any organ, if properly stimulated, may become a tuber. He defines a tuber as a fleshy body used for storage, whether morphologically stem, root, or leaf —a definition that the following results obviously require.

The experiments upon vicarious organs arrange themselves into two groups: a tuber may replace a stem when put in such a position that its normal function cannot be performed, or a tuber may be developed from almost any organ if the normal formation of tubers is suppressed. One of the most plastic plants studied was *Oxalis crassicaulis*, a plant which normally

[4] Prings. Jahrb. für wiss. Bot. **34**: 1–148. 1899.

resembles the potato in the development of subterranean stem tubers. A tuber placed in an erect position, partially below the soil line and partially above it, develops roots and rhizomes from the buried portions and green shoots from the aerial portions. Instead of decaying rapidly, as a tuber commonly does when it has disposed of its stock of reserve food materials, the Oxalis tuber, placed in this abnormal position, lives and grows through the entire season. The tuber is obliged to function as a stem, both in the conduction of water and the plastic foodstuffs and in giving mechanical support to the aerial organs. As a result of these new functions, the author finds a striking change in the anatomy of the tuber. Instead of the predominance of parenchymatous storage cells, there is a great increase in the area of the vascular bundles; the secondary phloem and xylem develop remarkably, and the new cells and cell fusions have a much larger cross section and more complicated structures. The strong development of bast fibers and wood cells materially adds to the mechanical strength of the tuber in its new relations. Thus the tuber has become like a normal stem in structure as in function.

The suppression of normal tuber formation in Oxalis stimulates their development in a new position. The plant sometimes develops stolons whose ends bury in the soil and develop tubers from the terminal bud. If this bud is removed, the bud nearest the end becomes a tuber, and if all the buds are removed one of the stolon internodes swells up like a tuber. In some cases the leaves instead of the internodes become tubers, and the leaflets may remain as rudiments or may swell up like the petiole. The structure of the petiole which functions as a tuber undergoes a remarkable change. The ventral furrow is absent, the petiole being round in cross section. There is no collenchyma, or green tissue, and the bundles which are so prominent in a normal petiole remain in a rudimentary condition; even the vessels which are present may be filled up with tyloses. The changed petiole is almost wholly made up of storage parenchyma. The starch grains here often assume the most fantastic shapes; indeed Vöchting commonly finds that the more abnormal the organ which becomes a tuber, the more abnormal are the starch grains, indicating an intimate correlation of structures of a surprising nature.

Experiments similar to those just mentioned were performed on the potato but were less successful as a rule, showing, the author thinks, that Solanum is less plastic and that the metamorphosis of stem to tuber has gone further than in Oxalis. A root of *Dahlia variabilis* was planted somewhat emerging from the soil. The new roots, which commonly form in a cluster at the base of the stem, formed at the base of the parent root, since the base of the stem was in the light. The next year the compound root system was planted with these new roots emerging from the soil, and new roots formed at the base of this second story of roots. This process was repeated until

finally four tiers of roots were developed. Each year the plant started later and later, and for a long time the leaves remained yellow, showing the difficulty the plants had in conducting materials up through the series of root tubers. The fifth year the struggle was too severe, and the plant died. These tubers did not develop buds and were hence incapable of propagating the species, but experiments showed that decapitated budless tubers can remain alive and fresh for several years. The Dahlia tubers developed a stem structure like those of Oxalis.

One of the most plastic plants employed was *Boussingaultia baselloides*, a plant with the potato type of tuber. This plant grows readily from cuttings, roots and rhizomes springing from the subterranean buds, and green shoots from the aerial buds. When cuttings are placed in the soil so that all buds are in the light, the base of the stem itself, *i. e.*, the buried internode, swells up into a tuber; if the base of the internode lies deep, the tuber is elongated, if shallow, it is shortened, showing the restricting influences of light in tuber formation. As in Dahlia, these tubers are budless and remain fresh and living for a year or two, but cannot propagate the species. The change in structure is similar to that in the Oxalis petiole which becomes a tuber. A leaf of Boussingaultia when placed in the soil gives off roots, one of which swells into a budless tuber; these tubers live and function if a shoot is grafted upon them. (Leaves of Gloxinia root similarly but develop buds and are capable of growth.) The experiments on this plant and on Oxalis seem to show a strong inclination toward tuber formation, an inclination which must be satisfied in one way if not in another. In *Thladiantha dubia*, a tuberous member of the melon family, the author succeeded in setting out a tendril and developing a starchy tuber from its base, which remained fresh long after the tendril died.

Vöchting carried on several experiments for the purpose of showing the influence of external factors, especially light and darkness, upon tuber formation. The restricting influence of light in the case of Dahlia and Boussingaultia has already been indicated. In the radish the tuber is partly root but mostly hypocotyl. Plants with all the hypocotyl and part of the root above the soil tended to develop elongated tubes, to which the root contributed half or more; in some cases all of the tuber was developed from the root. Etiolated seedlings were darkened at various points by tinfoil, and tuberous swellings appeared within the darkened areas, but always as near the top as possible. Two or three separate tubers were sometimes developed in this way on a single plant. Low temperature and drought were shown to facilitate tuber formation in Oxalis, but the internal forces are so strong that they are not effective early in the season, nor, on the other hand, will warmth and moisture greatly retard tuber formation in the fall. In this species also light is unable to prevent finally tuber formation, though it greatly retards it. The

strong tendency to tuber formation which finally overcomes all obstacles is due, the author thinks, not only to the internal force which looks to the propagation of the species, but also to a demand for organic symmetry; the occasional development of potato tubers without starch, and therefore functionally impotent, appears to favor this conclusion.

The author has thus been enabled to establish upon a firmer basis than ever before his ideas as to the great plasticity of plants and the vicarious nature of their organs. Perhaps the most astounding thing of all is the power shown by a mature organ, like the tuber of Oxalis or Dahlia, to be born again, as it were, and start on a period of secondary growth. The plasticity of a young organ is well known, and perhaps not so surprising, but one would scarcely have expected to see such evidences of life and vigor in a specialized organ like a tuber.— HENRY C. COWLES.

THE ORIGIN of the cilia of the spermatozoid is very briefly but clearly traced by Belajeff[5] in *Gymnogramme sulphurea* and *Equisetum arvense*. In Gymnogramme two centrosomes (the blepharoplasts of Webber and others) make their appearance at opposite poles of the nucleus of the grandmother cell of the spermatozoid. The division of this nucleus is not accompanied by a division of the centrosome, and consequently each of the resulting cells receives only a single centrosome. The centrosome, originally spherical, elongates into a narrow band lying alongside the nucleus, and the cilia arise from the peripheral portion of the band.

The sequence is the same in Equisetum, but here the writer was able to show that the band is made up of a row of intensely staining granules and a less deeply staining portion. Each granule gives rise to a single cilium.

The spherical organs which give rise to the band are regarded as genuine centrosomes, and Belajeff would homologize with them the blepharoplasts of Webber (Zamia) and Shaw (Marsilea and Onoclea), and also with the cilia-forming centrosomes of Hirase (Gingko) and Ikeno (Cycas). He would also homologize the cilia-forming band with the "middle piece" of the animal spermatozoon, as described by Hermann for the salamander.— CHARLES J. CHAMBERLAIN.

IN A STUDY of the influence of weather and the condition of the soil upon the anatomical structure of plants, W. Meyer[6] objects to culture experiments and goes for his material to nature, where plants may be found under the same conditions for many generations. He compares numerous members of the Caryophyllaceæ, chiefly alpine forms, and shows how species in different divisions of the same family have a close resemblance to one another when growing in similar situations. For example, species of the Sileneæ, Alsineæ,

[5] Ueber die Cilienbildner in den spermatogenen Zellen. Ber. d. deutsch. bot. Gesell **16**: 140–144. *pl.* 7. 1898.

[6] Bot. Centralb. **79**: 337–350. 1899.

and Paronychieæ growing in deserts resemble each other and also those on alpine heights, for in high altitudes the sun's rays are very powerful and plants need the same protection as in deserts. On the other hand, specimens of the same species, under various conditions, show extreme divergence. He also shows that many species of the Primulaceæ resemble those of the Caryophyllaceæ when grown under like conditions. Only a causal dependence between situation and structure can explain such resemblance, since common origin cannot do it. — L. M. SNOW.

SEEDS whose viability had been previously tested by samples were recently submitted by Professor Dewar to the intense cold of liquid hydrogen, *i. e.*, — 250° C. for half an hour. Some of the seeds were cooled in a sealed glass tube, and others were immersed without protection in the liquid hydrogen. All the seeds in both sets germinated. — C. R. B.

THE LITERATURE of diatoms has recently been enriched by a very important contribution.[7] The work is not merely a guide for the determination of the species of a limited locality, but is a comprehensive text-book of diatom lore. The author has departed from the usual comparatively superficial methods, and has taken into account the form and structure of the protoplast, the position of the nucleus, the number, form, and position of the chromatophores, the occurrence of pyrenoids, and, finally — a most important consideration — the complete life history of each species as far as this has been possible. A study of cell characters convinced the author that the number and position of chromatophores is the most important taxonomic character, and that mere frustule characters are not sufficient for determining the limits of species.

The second part of the work gives a somewhat extended account of the diatom cell, cell division, movements of diatoms, the relation of variety of form to environmental factors, the auxospores, and the rôle of diatoms in the economy of nature. — CHARLES J. CHAMBERLAIN.

THE PRODUCTION of apospory by environment has been brought about in various ferns. Mr. F. W. Stansfield[8] has succeeded in producing apospory in *Athyrium filix-fœmina, unco-glomeratum*, an apparently barren form. In all cases it was noted that prothalli are produced with much more ease from young fronds than from adult ones. If the first fronds from a prothallus are pinned down, the edges rapidly develop into prothalli. The aposporous production of prothalli is regarded as an atavistic trait, and the suggestion is made that apospory could be produced in many ferns by taking sufficient

[7] KARSTEN, GEORGE; Die Diatomeen von Kieler Bucht. Wissenschaftliche Meeresuntersuchungen herausgegeben von der Commission zur Untersuchung der deutschen Meere in Kiel und der biologischen Anstalt auf Helgoland. Abtheilung Kiel. Neue Folge **4**: 19–295. *figs. 219.* 1899.

[8] Jour. Linn. Soc. Bot. **34**: 262–268. 1899.

care. The fact that Mr. Druery, a few years ago, succeeded in producing apospory in *Scolopendrium vulgare*, presumably a most unlikely form for such an experiment on account of the smooth strap-shaped leaves, indicates that the suggestion has some weight.—CHARLES J. CHAMBERLAIN.

APPLE CANKER, which attacks the bark of the limbs of apple trees of all ages, has been traced by Mr. W. Paddock,[9] of Geneva, N. Y., to the well-known *Sphæropsis malorum* Pk., causing the black rot of apples. Cultures have been made on sterilized bean stems, and the disease produced by inoculation. In a later communication[10] further observations are given upon the destructiveness of the disease, which occurs, as it is discovered, in pears and quinces as well as in apples. Trees may be entirely killed by this disease, which in most cases progresses from the smaller branches toward the trunk.—J. C. A.

WEEDS have been the subject of a number of bulletins from the agricultural experiment stations, not yet mentioned in these pages. Only the western states are represented. F. H. Hillman (Nev. no. 38: 1–131. 127 cuts in text) describes the seeds of many weeds with much clearness and detail, and presents one hundred and twenty five cuts, drawn by himself, illustrating as many kinds of seeds. These illustrations are worthy of special commendation for their accuracy and artistic merit, and also because they are well printed. L. F. Henderson (Idaho no. 14: 91–136. 13 pl. and 5 cuts in text) discusses twelve of the state's worst weeds, and says good things about the value and justice of weed laws. E. E. Bogue (Oklahoma no. 41: 1–12. 14 cuts in text) presents information regarding seventeen weeds, of which those least known eastward are *Solanum Torreyi*, *Acacia filiculoides* and *Croton Texensis*. A. S. Hitchcock and G. L. Clothier have issued a press bulletin (no. 18) of two pages giving notes on weeds, and also a sixth report on Kansas weeds (Kans. no. 80: 113–164). A large fund of information is presented regarding the habits and distribution of weeds, not only of Kansas, but of the whole United States. Charts are used to show the distribution by counties in Kansas of 209 species, and by states in the whole country of 194 species. L. H. Pammel presents a full account (Iowa no. 38: 7–24. 7 cuts in text) of the Russian thistle, with a bibliography; also a discussion of the weeds of cornfields (Iowa no. 39: 27–52. 17 cuts in text), and of horse nettle (*Solanum Carolinense*), *Convolvulus arvensis* and *Tribulus terrestris* (Iowa, no. 42: 130–140. 5 cuts in text), the last species having recently gained a foothold on Muscatine island in the Mississippi river. E. S. Goff (Wis. no. 76: 1–53. 39 cuts in text) gives illustrations and information regarding the ten weeds mentioned in the Wisconsin weed law, with notes on eight others.—J. C. A.

[9] *Science* **8**: 595.

[10] *Science* **8**: 836.

THE RUST FLORA of California, according to E. W. D. Holway in the October *Erythea*, embraces 122 species of Puccinia, 42 of Uromyces, and 73 of other genera.—J. C. A.

ANOTHER ARTICLE[11] has recently been added to the valuable series of physiological papers already so auspiciously inaugurated by Dr. Klebs. The same ingenious accurate experimentation which characterized the earlier papers of the series is evident. The presentation is masterly. The purpose of the research is to determine the chemical and physical factors which incite or alter the various modes of reproduction in *Saprolegnia mixta*. It is found that this species will grow indefinitely without either sexual or asexual reproduction if nourishment be abundant; but at any time the extensive formation of zoospores can be incited by simply starving the hyphæ, *e. g.*, by placing them in water. By noting the maximum concentration at which various foods induce the formation of zoospores an idea was obtained as to their relative food value. Albumens are rich; amido-acids can furnish C as well as N; in general the food value rises with the carbon content; glucosides vary from toxic to indifferent or even favorable; inorganic acids and their salts are of but little value.

By varying the nutritive value of any medium the fungus can be made at will to assume a purely vegetative condition; to produce rudimentary sporangia; to form sporangia which bear zoospores that do not escape; and to produce functional zoospores. All of these phenomena depend for their existence upon the concentration of the medium, not upon the total quantity of nutriment.

It happens, however, that even in strong solutions the formation of zoospores is often eventually suppressed. This led Dr. Klebs to infer the presence of an inhibiting agent formed in the medium by the growth of the fungus. One such substance he finds is ammonium carbonate. If the medium be rendered weakly acid zoospore formation can be resumed. Starvation, if very gradual, causes the mycelium to become too weak to build zoospores. Poisons inhibit their formation as does also high osmotic pressure. Experiments show very clearly what are the necessary relations and also the responses, but the reasons for both are totally obscure. Zoospores are never found unless the tips of the hyphæ are in contact with water. Oxygen, light, and heat are of little importance.

If a well nourished mycelium be placed in a poor medium where the conditions render the formation of zoospores impossible, *e. g.*, in a solid medium, sexual organs will soon appear in abundance. These, however, are sensitive to heat (their maximum being 26°, that of sporangia 32°) and fastidious as to

[11] Zur Physiologie der Fortpflanzung einiger Pilze: Jahr. f. wiss. Bot. **33**: 71. 1899. Reviews of earlier papers may be found in this journal **23**: 214. 1893, and **27**: 77. 1899.

their inorganic food, seeming quite dependent upon the presence of some form of potassium phosphate. This is particularly true of antheridia, and by varying the medium a filament may be obtained which bears no sex organs, or one bearing only oogonia, or one with oogonia and a few antheridia, or, finally, one with many antheridia some of which form fertilizing tubes. In this connection it should be recalled that specific distinctions have been based on the abundance of antheridia. In general the relation between oogonia and antheridia is such that support is given to the view of DeBary, viz., that the presence of oogonia induces the formation of antheridia. Dr. Klebs thinks this is due either to chemotaxis when proper inorganic salts are present, or that these salts render the twigs sensitive to the chemical stimulus emanating from the oogonia. It is evident, however, that normal oogonia can exist without inducing antheridial formation.

While as conclusively proved in this research, there is no dominating inherent tendency toward an alternation of generations, nevertheless the conditions are such that in nature an alternation is usually brought about through the exhaustion of the nutriment afforded by each newly attacked host.

Previous to oosphere formation the incipient oogonium may revert to a vegetative condition, but after the oospheres are differentiated the power to vegetate is irretrievably lost. This, the author thinks, is due to nuclear changes possibly to a chromosome reduction.

An interesting chapter is given to the consideration of gemmæ and the author concludes, apparently with ample ground, that they are of no significance in phylogeny. They are special structures whose function is to tide over times when the formation of other spores is precluded. They behave in general as do hyphæ, and develop into oogonia or sporangia according to environment. Dr. Klebs closes by saying that an acquaintance with mere morphological marks does not constitute sufficient knowledge of a species. To meet his high ideal the systematist must hereafter determine, both quantitatively and qualitatively, the life relations of the plant, its limits of variation, and the stimuli that cause these variations.—F. L. STEVENS.

WHETHER THE Saprolegniaceæ are exclusively apogamous or not is a question that has been argued *pro* and *con* in pre-cytological days by DeBary, Pringsheim, Cornu, Zopf, Ward, Humphrey, and others. Four years ago Messrs. Hartog and Trow almost simultaneously published papers expressing quite opposite views regarding fertilization in this group. Trow has recently made extended researches on Achlya[12] and arrives at conclusions in harmony with his earlier paper. He describes a karyokinetic division of the oogonial nuclei and a degeneration or digestion of the supernumerary ones, so that only

[12] Trow, A. H.: Observations on the biology and cytology of a new variety of *Achlya Americana*. *Ann. Bot.* **13**: 131.

one remains to function in each oosphere. Trow is convinced that true fertilization, a fusion of sexual nuclei, does occur. It is to be regretted, however, that his technique was not improved to such a point of efficiency as to insure more unequivocal evidence than he presents. The final impression that is left with the critical reader is that Trow has seen some things which make a fertilization seem possible, or even probable; but that it is far from being proved. A really valuable feature of Trow's work consists in the observations on live material, by which he has followed the growth of the organism from the zoospore to complete maturity, including development, ripening, and germination of the oospores.

An article which bristles with caustic but mainly petty criticism regarding Trow's conclusions and theories appears in the September *Annals of Botany*.[13] This criticism, like Hartog's criticism of Trow's earlier paper, while it increases the literature by several pages, sheds no light on the perplexing questions.— F. L. STEVENS.

[13] HARTOG, MARCUS: The alleged fertilization in the Saprolegniaceæ. *Ann. Bot.* **13**: 447.

NEWS.

MR. ALBERT H. TROW has been granted the degree D.Sc. by the University of London.

PROFESSOR ERNST EBERMAYER has resigned the professorship of forestry in the University of Munich.

MR. W. L. JEPSON has been promoted from the instructorship to be associate professor of botany in the University of California.

MR. R. K. BEATTIE has been appointed instructor in botany in the Agricultural College of Washington, located at Pullman.

DR. JOHN M. COULTER will be away from his post at the University of Chicago for nine months. He is spending the winter at Washington, D. C.

MR. GRANT ALLEN, author of several popular books and papers on botanical subjects, and more lately widely known as a writer of acknowledged fiction, died October 25, in his fifty-first year.

MR. H. H. HUME, assistant in the departments of botany and horticulture in the Iowa Agricultural College, has been elected horticulturist and botanist of the Florida Agricultural College at Lake City.

THE EXTRAORDINARY delay in the publication of the October number was due to the illness of the present managing editor from October 13 to November 4, and the absence of the senior editor.

TWO SCHOLARSHIPS for garden pupils in the Missouri Botanical Garden will be awarded by the director, Dr. Wm. Trelease, before April first next. Applications must be in his hands not later than March first.

MR. A. A. HELLER, of Lancaster, Pa., will start for Porto Rico on a collecting trip about January 1. He expects to bring back a large and interesting collection of all classes of plants. The cryptogams of that island should be an especially interesting study.

PROFESSOR DR. PAUL KNUTH, whose recent return from a tour around the world, including a somewhat prolonged stay in this country, we lately chronicled, died in Kiel on October 30, at the age of forty-five. His death will be felt as a severe loss to ecology.

MR. J. W. DUVEL, of the Agricultural Experiment Station at Wooster, Ohio, has been appointed to the D. M. Ferry Botanical Fellowship in the

University of Michigan. Mr. Duvel has begun an investigation of certain factors affecting the vitality and germination of seeds.

PROFESSOR IGNATIUS URBAN announces that the second fascicle of his Porto Rico plants is now ready for distribution, the price per hundred being *M* 40. A few sets of the first fascicle may still be obtained, at *M* 30 per hundred. Professor Urban's address is Grunewald-strasse 6/7 Berlin W.

PROFESSOR JEAN BAPTISTE CARNOY, professor of botany in the Catholic University of Louvain, died on September 8, at the age of sixty-three. Professor Carnoy was the founder and editor of the elegant periodical *La Cellule*, and the author of several works and papers of high value on cytology.

THERE HAS come into the possession of the city of Philadelphia the dwelling and part of the grounds which belonged to James Logan (1674–1751), with Penn one of the founders of Pennsylvania, and a botanist of note, after whom *Logania*, the type of the Loganiaceæ, was named by Robert Brown. The property will be known as Stenton Park, the original name of the Logan estate, as there is already a Logan Square in the city. Mr. Thomas Meehan, the venerable horticulturist, has been the mover in the proceedings which have secured the preservation of the grounds of Bartram, McMahon, and Logan.

MR. J. B. ELLIS being unable to continue the issue of *Fungi Columbiani*, has requested Mr. C. L. Shear, of Takoma Park, D. C., to take charge of it. Mr. Shear has acceded to this request, and seeks the cooperation of working mycologists and collectors. Mr. Ellis will assist in the determination of material, and doubtful specimens of the various orders will be submitted to other specialists. The series of North American Fungi has been discontinued, but the present series is in great part a continuation of it. Century XV is now in course of preparation. Complete sets of the first fourteen centuries can still be supplied.

ON JANUARY 1 the Cambridge Botanical Supply Company will discontinue the publication of the card index of American Botany, and the committee appointed by Section G of the A. A. A. S. is seeking to continue it under other arrangements. The present subscription price of $5 per year was made when only about 500 cards were issued and is inadequate to support the enterprise with the increased number of titles. It has, therefore, been decided to make the rate one cent per card. The number of subscribers will govern the number of sets printed and the matter will not be electrotyped. Intending subscribers should at once notify Professor L. M. Underwood, Columbia University, New York city.

MR. MATURIN L. DELAFIELD, JR., 56 Liberty street, New York city, having fulfilled the requirement of the constitution of the Botanical Soceity

of America, becomes a patron of that organization. At the Columbus (O.) meeting last August, among other amendments to the constitution of the society, one was adopted admitting patrons. The clause relating to patrons reads as follows:

> The payment to the treasurer of the sum not less than $250 at any one time, or a bequest of such sum, shall constitute the donor a patron of the society. The names of patrons shall be published with the annual lists of officers and members, and the patrons shall be entitled to receive copies of all the publications of the society. Patrons' fees shall be added to the permanent fund of the society.

Mr. Delafield, therefore, becomes the first patron of the Botanical Society of America.— GEORGE F. ATKINSON, *Secretary*.

THE MISSOURI BOTANICAL GARDEN has this summer received a decision from the Supreme Court of Missouri which empowers the trustees of the garden at their discretion to sell unproductive endowment real estate, which was made inalienable by the will of Henry Shaw, the founder of the garden. While it is not probable that sales will be made rapidly, the purpose being to effect them at full market value, the power to dispose of this property promises to add many thousand dollars to the annual revenue of the establishment within a few years, and it makes available for immediate use each year some ten or fifteen thousand dollars which business wisdom has compelled the trustees to hold out of the current income thus far, as an emergency fund for the protection of the property when street improvements and other special expenses should be forced upon it.

Immediate use is to be made of some of the money thus liberated, by the addition to the garden of about twenty acres of ground, to be graded and planted in accordance with plans made by the landscape architects, F. L. and J. C. Olmsted, and to represent in synopsis the principal features of the North American flora.

5263
B.S. pl.